JUNIOR PLANES

BY EDWIN M. LOVE

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FOREWORD

Twenty-two planes are described in this book. All of them have been built and flown, and all of them have proved themselves to be good performers.

To build one of these models, it is necessary only to read the chapter telling about it, as the descriptions are complete for each one. However, some points are covered more fully in one article than in another; and if more information is wanted on the carving of a propeller or the bending of a shaft, a glance at the drawings for some of the other models will give the needed help.

Although regular airplane model supplies have been specified, there are substitutes that are much cheaper, and just as satisfactory. For instance, instead of the rather expensive papers ordinarily used, wrapping tissue, costing one-twentieth as much, may be purchased; and as to ambroid, or other glues, a home-made cement is equally good. Simply get scraps of old celluloid automobile side-curtain lights, obtainable at any wrecking yard for ten cents a pound, and dissolve a few pieces in a pint of acetone, cost-

ing thirty-five cents. Pour the acetone into a convenient bottle, add the celluloid, and let stand for a few hours, occasionally turning the bottle upside down to help in mixing. The same glue, when thinned, makes good wing dope.

In building these models, remember that air friction slows up a flight, and consequently reduces duration. If spars and struts are streamlined, and sanded smooth; and if the paper is tightly stretched, the air will flow past without much eddying, giving the best possible flight.

Dedicated to my little boys, John and James, who all too soon will be old enough to build these planes.

Edwin M. Love

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PART I

GLIDERS

1

THE MIDGET BALSA SAILPLANE

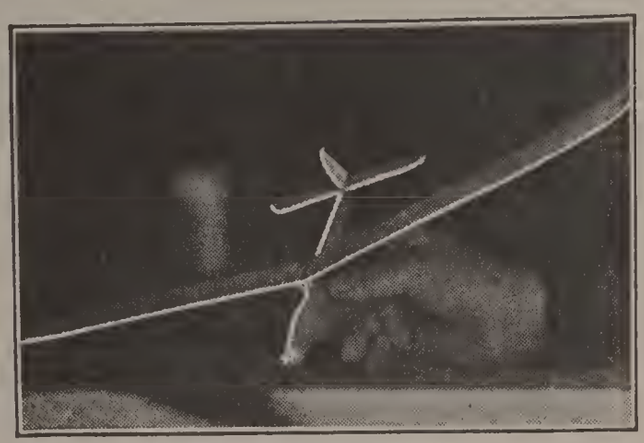
Can a tiny, all-balsa glider fly well? Build this little sailplane, and see for yourself. Trim lines it has, with its shapely fuselage and slender wing. It has a very high aspect ratio; that is to say, while the wing spread is 20″, the chord of the wing is only ¾″; and this, together with the fact that the supporting surface is cambered, makes a very efficient flier.

This little plane glides nicely indoors, but of course does better outside. The writer's model, on a cool day with winds none too favorable, stayed up more than a minute when launched into the breeze from a hill side. On a hot, dry day with a proper wind, it might sail for two minutes.

But few materials are needed. Get a piece of $\frac{1}{16}$″ balsa veneer ¾ by 12″, for fuselage, stabilizer, and rudder; and for the wing, a piece of ¼ by ¾ by 20″ balsa. A small ring paper clip, bits of nails, and ambroid cement complete the list.

Make a paper pattern of the fuselage. Notice that the under edge is gently curved most of the distance from the

tail end, but rounds upward sharply at the nose. The upper edge is an almost flat curve from the nose to the cockpit, which is ¾″ wide, situated 1½″ from the nose.



A straight slope from the cockpit to the tail completes the body of the machine.

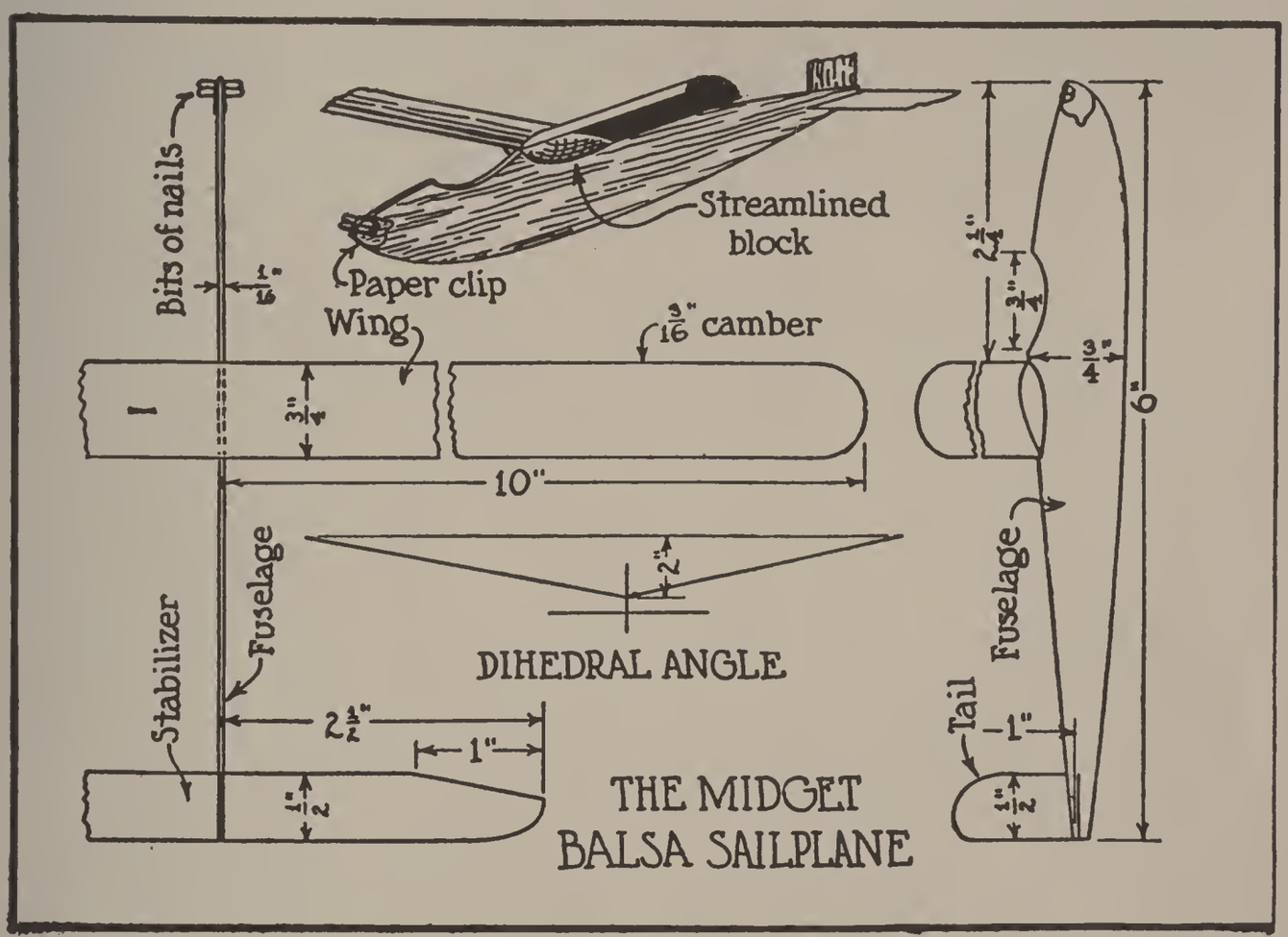
To make the wing, carve out the underside with a gouge, and smooth with sandpaper on a round-edged block. Most of the curve, or camber, is near the front edge. When the under side is carved, shape the upper side, reducing the wing to a thickness of less than $\frac{1}{16}$″. Wrap the sandpaper around a block of wood when smoothing the wing, as this will help to keep it straight. Cut the tips round, and then round the edges.

You may find, after going to all this trouble to give camber, that the wing has flattened out. If this happens, wet it on both sides with water, and lightly wind it with string, having the loops no more than ¼″ apart for full length. Draw the string tightly enough to bring back the curvature, and lay the piece aside to dry. Be sure, however, that it does not lie in a twist.

After drying, cut in from the edges toward the center at the middle, until the tips can be bent up 2″ for the dihedral angle. Apply cement above and below the break,

then block into position, and let the wing dry thoroughly.

The stabilizer is ½ by 5". Carefully shave and sand it until it is no thicker than a thin visiting card. When using the sandpaper, lay the balsa on a flat block of wood, and there will be no trouble in thinning it evenly. Trim



it to the correct shape with a very sharp razor blade.

Cut a ½" slit in the tail end of the fuselage. It should follow a line drawn along the center of the body, and must be widened until the stabilizer can be slipped into it. Put ambroid on the edges, and above and below the stabilizer across the center, before inserting the latter in the slit. Hold it at right angles to the fuselage until the glue has stiffened enough to keep it in place.

The tail, or rudder, is ½ by 1″, and the same thickness as is the stabilizer. Ambroid it to the upper edge of the body, above the stabilizer.

Cement the wing to the body, having the leading edge 2¼″ back from the nose, and ⅛″ higher than the trailing edge, measuring from the center line. Fit $\frac{3}{16}$″ square blocks against the body and beneath the wing, so as to strengthen the joint. After the glue has dried, streamline these blocks.

The glider is now ready for flying. Slip a small paper clip over the nose, and two ¼″ lengths of nails about $\frac{3}{32}$″ in diameter through the wood under the upper edge of the clip, where they are cemented.

Launch the plane by tossing it lightly forward and a little downward. If it repeatedly nosedives, take off some of the weight, but if it stalls when thrown fairly hard, add a little more. If it turns to the side when fair with the wind, give a little twist to the tail. It may be, too, that the wing is a little twisted, causing one side to drag. If so, breathe on that part, to moisten it, and twist it back.

Long flights must be made from a hill side, where the wind, not too strong, blows toward it. If the breeze is right, the little plane may rise quite high before beginning its final downward glide.

For short glides indoors, remove the bits of nails and try the ship on slow glides. Add a pin if necessary. When

pointed almost straight down and released from a height of seven feet, it should level off and skim away before touching the floor.

The little plane may be decorated by staining it with water colors or rubbing it with wax crayons; but be sure that it is not twisted when drying, or it will remain that way.

2

A THREE-FOOT BALSA GLIDER

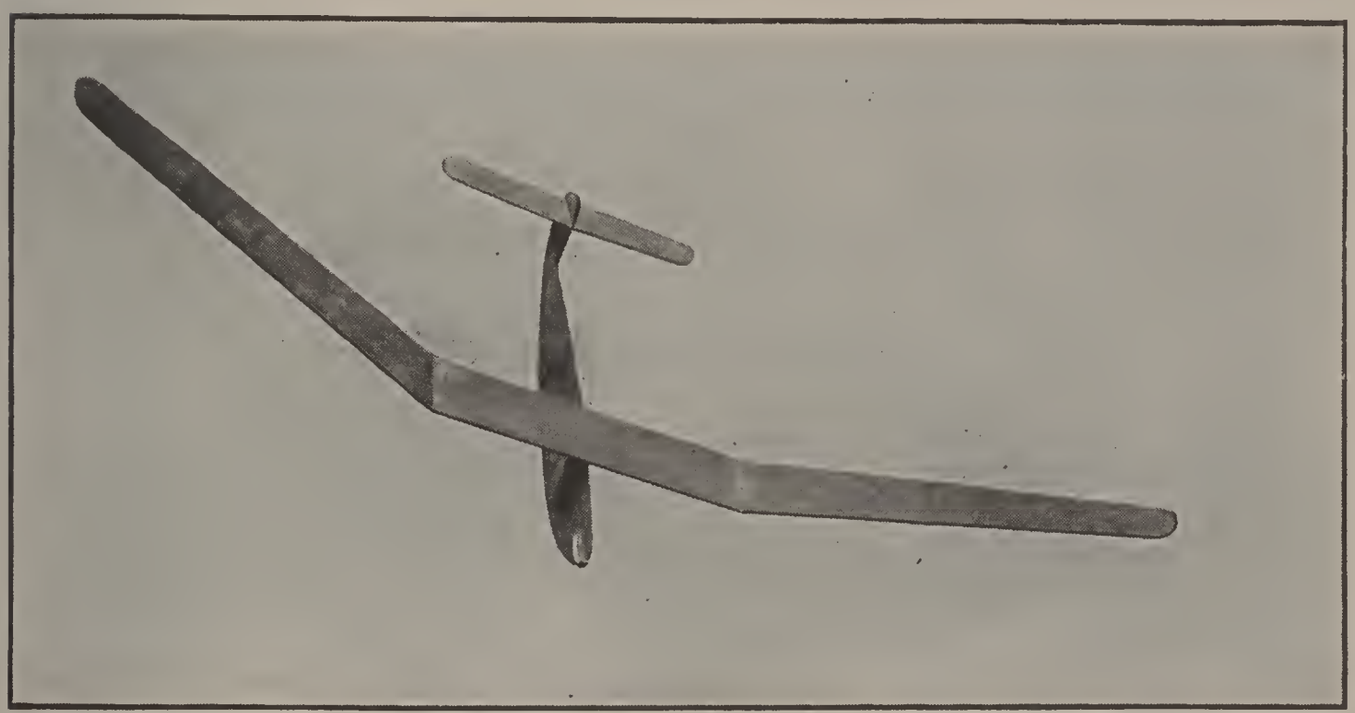
It is said that a condor, high in the air, can come into sight as a tiny speck in the east, soar on outstretched wings overhead, and disappear in the west, without so much as flapping once to supply motive power for his flight.

Flying men nowadays are spending much time studying soaring, and motorless gliders have stayed aloft many hours. Such flights are possible because in many places the wind blows upward with a good deal of force. For instance, a breeze moving toward a hill is turned upward. When a glider is launched by towing it down the hill at the end of a shock cord, it rises like a kite, gaining considerable elevation after being released, for the pilot guides it skillfully in the rising air. Actually, he is not flying upward according to the air, but is gliding downward, at a slower rate, however, than the upward speed of the current. By circling, a great height may be reached, when he can steer toward some distant hill where another rising current will carry him aloft once more.

He may be fortunate enough to fly over a hot, bare stretch of fields and rocks, where the heated air rises almost

as strongly as at a hill. Then his chances for a long flight are very good indeed.

Some wonderful flights have been made by large, well-built model gliders. Durations of half an hour are not unknown. This chapter describes a simple balsa glider that will soar splendidly over a hillside in a fair breeze,



or will make long, graceful glides above the level after a light toss from the hand.

For this model a piece of $\frac{1}{8}$ by 3 by 36″ balsa, and one $\frac{1}{8}$ by 2 by 24″ are needed; also two pieces $\frac{1}{2}$ by $\frac{1}{2}$ by 3″, a piece of lead or solder that can be pounded into a flat strip $\frac{1}{16}$ by $\frac{9}{16}$ by 2″, and some ambroid cement.

Use the 3″ balsa for the wing. Gauge it for $2\frac{3}{4}$″ width along the center, cut it $35\frac{1}{2}$″ long, and square a line across the upper side 13″ from each end. Measure back 2″ from the leading edge at the ends, connect these points with the

2¾″ width at the cross lines, with straight pencil lines, and trim the taper with a razor blade. Cut the corners of the ends, finishing by rounding them smoothly.

Sand the wing on both sides, then taper the thickness of the edges by sanding them down from the upper sides, making the leading edge fairly blunt, with a short taper, and a long taper behind.

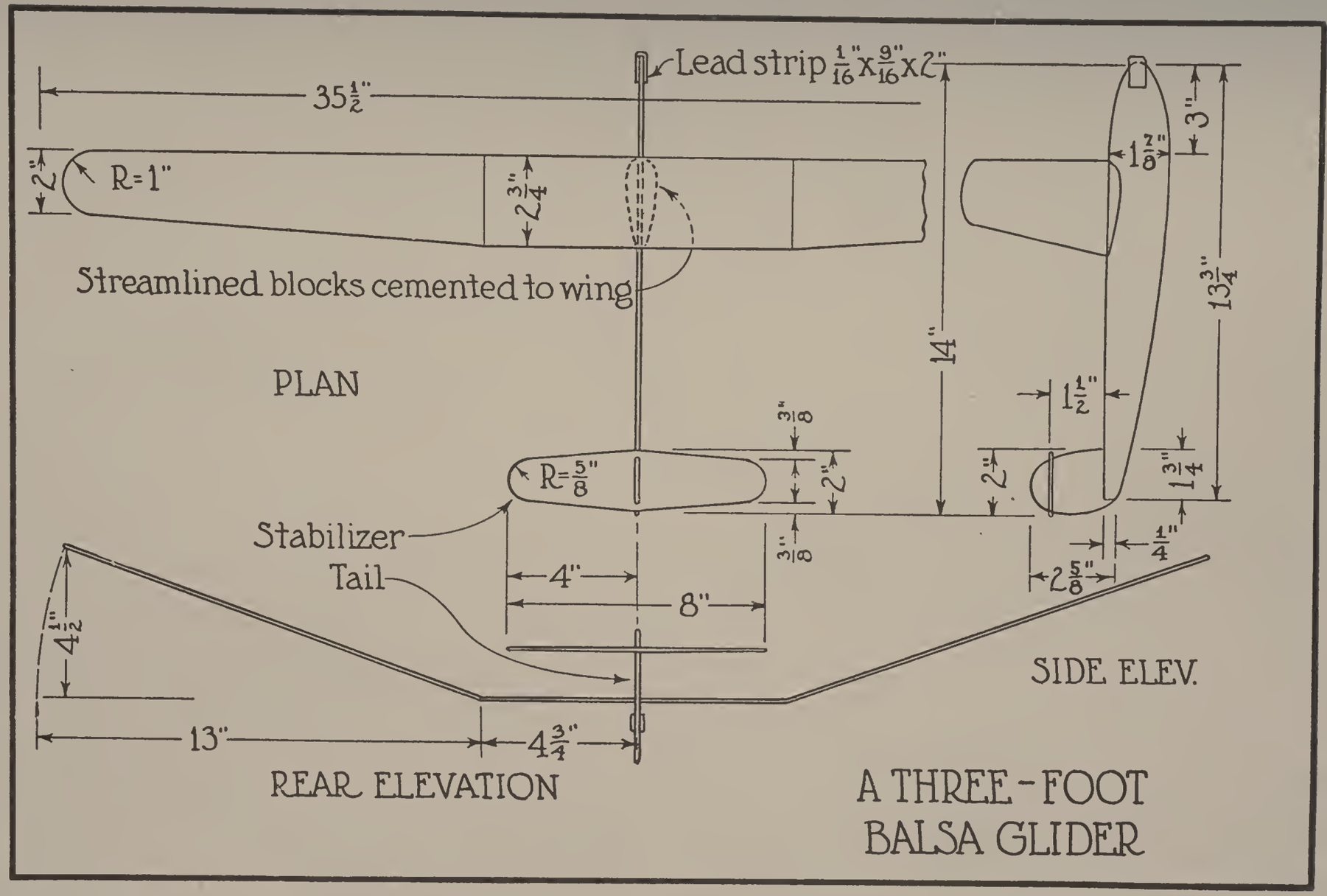
Now place a wooden block under one cross mark and another 3½″ from the far wing tip. Press down on the other mark with the edge of a ruler, until the balsa touches the bench. Still holding the ruler there, push the blocks gradually toward the ruler until the balsa cracks beneath, but be careful not to break the tip entirely off. Crack the other tip in the same way. Then fill the ragged undercracks with ambroid, block the wing with the tips 4½″ above the center, and let the wing dry.

Make two quarter-streamlined blocks 2¾″ long, using the ½″ square blocks. These resemble parts of a cigar quartered lengthwise, but with the thickest parts forward of the center.

When the wing is dry, square a line across the center, on the underside, and glue the blocks each side, with ⅛″ between.

The fuselage, of neatly streamlined shape, is 13¾″ long and 1⅞″ at the widest point.

The tail is ⅛ by 2″. Notch one end to fit around the


Lead strip 1/16" x 9/16" x 2"
35 1/2"
2"
R=1"
2 3/4"
Streamlined blocks cemented to wing
PLAN
14"
3"
1 7/8"
13 3/4"
1 1/2"
3/8"
R=5/8"
2"
2"
1 3/4"
Stabilizer
Tail
3/8"
4"
8"
1/4"
2 5/8"
4 1/2"
SIDE ELEV.
13"
4 3/4"
REAR ELEVATION
A THREE-FOOT
BALSA GLIDER

trailing end of the fuselage, as the drawing shows, and glue it there. Then shape it up with the razor blade.

The stabilizer remains. Use a piece of balsa 1/8 by 2 by 8". Trim it with the tips sloping back from the center 3/8". Round the corners to a radius of 5/8", and taper the thickness. Across the center cut a slit to fit over the top of the tail, where it is glued with the leading edge 1½" above the fuselage and 1/8" lower than the trailing edge.

Hammer and trim the lead to shape, bend it into a "U," and force it on the nose of the fuselage, where it is glued.

Put the wing astride the body, 3" back of the nose. The blocks should clasp tightly enough to hold it for trial flights.

Glide the plane by tossing it forward and a little down. Move the wing forward or backward, until a good glide is obtained, and glue it in position.

For soaring, climb a hill on the windward side, cast the ship against the wind, and watch it go.

3

A CONVERTIBLE GLIDER

Gliders have a great point in their favor—they need no rubber for motors, and so are very inexpensive to fly. Boys who are fortunate enough to live on or near hills can have as much sport with gliders as with powered models.

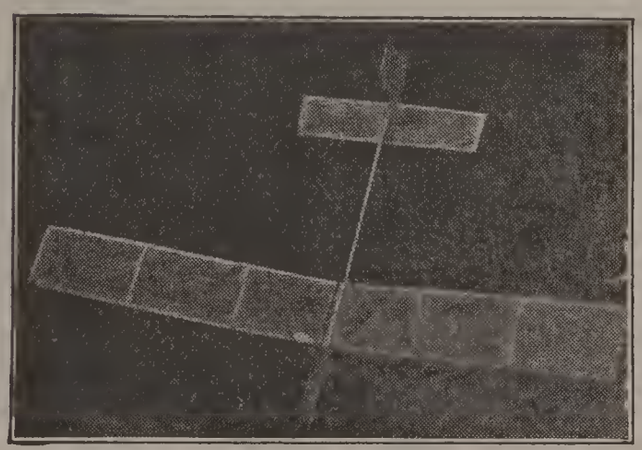
The *Convertible Glider* is an efficient little sail plane that is easy to build, and that can be made into a powered machine simply by adding a bearing, a propeller, and a few rubber bands.

These materials are needed: For spars and ribs, four pieces of $\frac{1}{16}$ by $\frac{1}{8}$ by 20″; for the stick, one piece $\frac{1}{8}$ by $\frac{1}{4}$ by 10″; for the saddle, 1 piece $\frac{3}{8}$ by $\frac{1}{2}$ by 2″; for nose weight, 1″ of $\frac{1}{8}$″ wire solder; also rice paper 4 by 20″, ambroid cement, mucilage, wing dope, and a rubber band of $\frac{1}{16}$″ square stock.

Divide two of the 20″ spars into spaces for the placing of ribs, measuring $3\frac{3}{8}$″ from the ends for the first inner, and the same distance farther on for the next. Cut seven ribs 2″ long, and glue these on top of the spars.

Bend the spars at the middle to make a dihedral 2″ deep. Roll a pencil along the forward ends on the undersides of

the ribs, giving a shallow camber to the wing, and cover the upper side with paper, applying mucilage to the leading and trailing edges, and all ribs. Cover only half the wing at a time.



Sand the stabilizer spars and ribs to $\frac{1}{16}$″ thickness. Cut two spars 6″ long, three ribs 1¼″ long, and assemble them as the wing was put together. The ribs, however, are left flat.

Build the tail of $\frac{1}{16}$ by ⅛″ stock. For the base use a piece 2¾″ long; for the trailing spar, a 2″ length, and for the other two pieces such lengths as will shape up the tail illustrated. The projecting front end of the tail base is cemented under the stabilizer, and the whole assembly is ready for mounting.

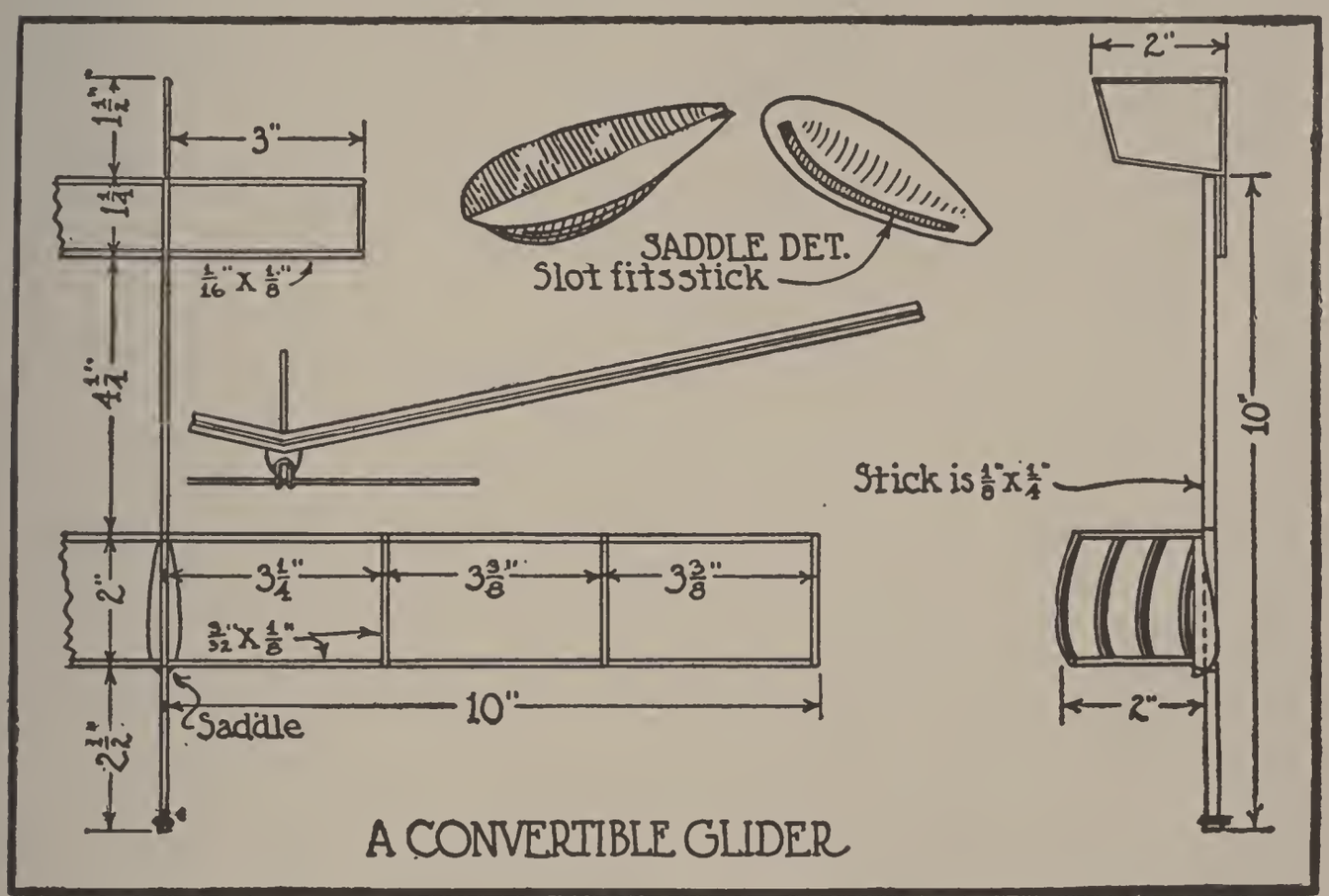
The body stick is merely the heavy balsa sanded smooth, with the tail glued beneath.

To carry the wing, a streamlined saddle is shaped, V-form above to fit the dihedral, and rounded below. Cut a slot lengthwise to fit over the stick.

Bend the solder into a "U" to fit the front end tightly. Cement it there. Also tap the front end lightly with a hammer to mushroom it a bit as an extra help to keep the weight from slipping off.

Loop the rubber band over the stick and wing, and adjust the saddle so that the leading wing spar rests on its front end, while the trailing spar slips past the saddle end and bears on the body stick.

The ship is now ready for a trial. It will ride about right with the wing 2½" from the front end of the stick, but a



A CONVERTIBLE GLIDER

little shifting backward or forward will probably be needed to get a good glide.

Launch it with a light forward and slightly downward toss, against the wind. There is much sport in gliding it in the street or any open space, but to get a long flight it is necessary to launch it from a hillside when a soft breeze is blowing up the slope. The thrill of seeing it jockeying

in the wind will repay any work expended in making it.

If you wish to add a propeller, carve it from a balsa block $\frac{5}{8}$ by 1 by 7″, using a $\frac{1}{32}$″ music wire shaft and tail hook, and if a winder is to be used, an S-hook of the same wire.

For a bearing use a $\frac{1}{16}$ by $\frac{1}{8}$ by $1\frac{1}{4}$″ aluminum strip, bent up suitably and cemented to the nose of the stick in place of the solder weight.

4

BUILDING A SIX-FOOT SAILPLANE

Build the sailplane described in this chapter, and you will have a ship that will stay aloft as long as anyone could wish. The original was designed by Martin Moad, a sixteen-year-old Los Angeles school boy, who has some 200 plane models to his credit. It has made flights of nine minutes—purposely limited to keep the model for measurement.

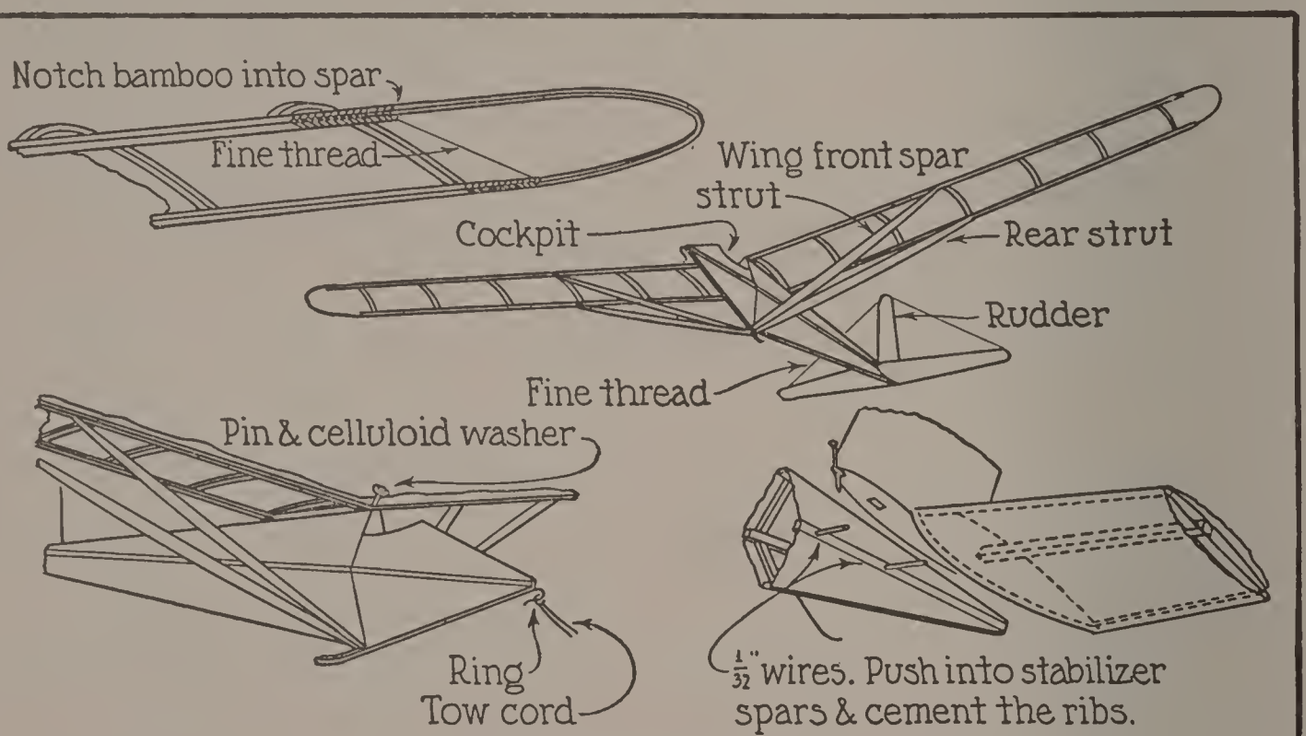
Use soft balsa for all wooden parts. Cut the wing spars, smooth them with sandpaper, and round the corners. Lay them in position on a bench for a center width of wing of 5⅞″, with 3⅝″ at the ends. Hold them with pins at the edges, being careful to make a uniform curve in the trailing edge. Lay out for ribs 5″ apart on centers.

Take the rib lengths from the frame, and raise their cambers by rolling the undersides with a pencil. Scarf the ends for cementing to the tops of the spars.

Shape the bamboo wing tips over a candle flame, holding the glossy sides out, and bending gradually. Glue them to the outer edges of the spar ends, flush with the top, and bind with thread, which is drawn across the wing to prevent spreading.

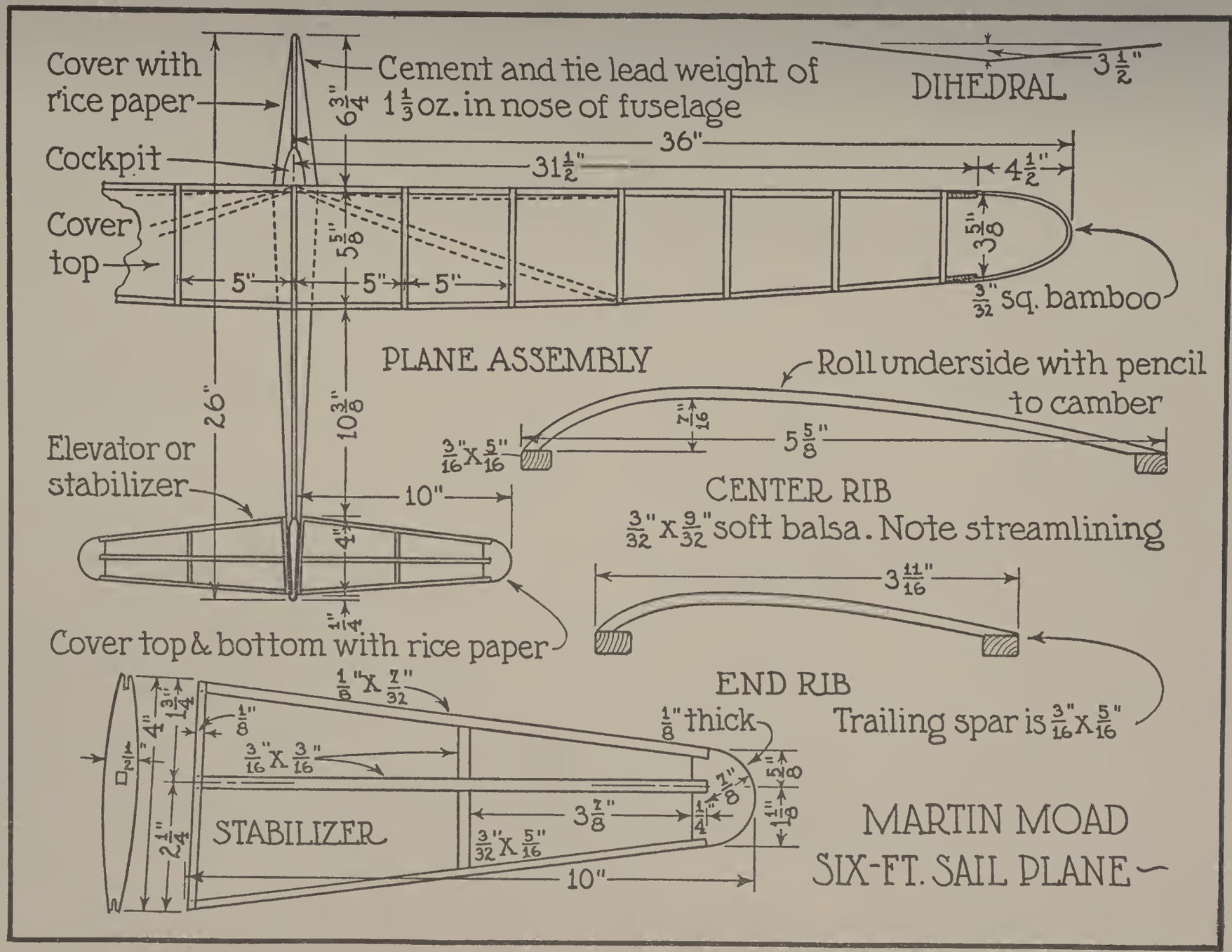
For the dihedral, break the undersides of the spars at the middle, so as to raise the wing tips 3½", where they are blocked until the cemented breaks can dry.

Cover the upper side of the wing with rice paper. Mucilage is good for this work, as it dries slowly, giving time for adjustments. It is necessary to paste the tissue to all the ribs.



ASSEMBLY DETAILS

For the fuselage cut the longerons, and shape the diamond bulkhead to pattern. Make the notches to fit the longerons, trim the sides, and cut out the center. Break the longerons 6⅞" from one end, as the wing spars were broken, and cement them into the bulkhead notches. Cement the ends of the top and bottom longerons together, and miter the other strips to fit against them.


Cover with rice paper
Cement and tie lead weight of 1 1/3 oz. in nose of fuselage
DIHEDRAL
3 1/2"
Cockpit
6 3/4"
36"
31 1/2"
4 1/2"
Cover top
5 5/8"
5"
5"
5"
3 5/8"
3/32" sq. bamboo
PLANE ASSEMBLY
Roll underside with pencil to camber
26"
10 3/8"
7/16"
3/16" X 5/16"
5 5/8"
Elevator or stabilizer
10"
CENTER RIB
3/32" X 9/32" soft balsa. Note streamlining
4"
3 11/16"
1/4"
Cover top & bottom with rice paper
END RIB
1/8" X 7/32"
1/8" thick
Trailing spar is 3/16" X 5/16"
1 3/4"
4"
1/8"
3/16" X 3/16"
1/2"
5/8"
7/8"
1/4"
3 7/8"
1 1/16"
STABILIZER
2 1/4"
3/32" X 5/16"
10"
MARTIN MOAD
SIX-FT. SAIL PLANE

Put in the cross posts, butting them between the longerons to hold them straight. Pieces are also mitered between the longerons 3″ from the nose, and two such struts, 2″ forward of the bulkhead along the upper spar, incline backward at the lower ends. Cut away the section of the upper longeron between these braces and the bulkhead, and glue in the $\frac{1}{64}$″ music-wire sides joining the bulkhead, thus trimming the cockpit.

To prevent the paper cover from sagging inward from air pressure, glue a horizontal semicircle of ⅛″ balsa to the bulkhead, 1″ below the side longerons.

A $\frac{1}{16}$ by $\frac{3}{16}$″ bamboo strip curved upward at the trailing end and glued to the underside of the fuselage nose acts as a landing skid. The tail skid is a large pin or other short wire stuck into the lower longeron 4″ from the end. Make the wing cleat to be glued to the upper longeron to carry the wing.

The towing hook is tied and cemented in a groove in the underside of the bamboo, directly beneath the nose.

Cement and tie in the nose two pieces of solder or lead, one ⅜ by ⅜ by 1⅝″, the other, above it, 1⅛″ long. Both are pushed forward as far as possible.

Cover the fuselage with rice paper.

The elevator stabilizer is next. Draw a pattern of one-half on a board, remembering that the inner rib fits against the fuselage, and so is at an angle. Notch the inner ends

into a streamlined rib 1/8″ thick, and the other ends into a semicircular tip 1/8″ thick. Taper the center spar into the tip, round the leading and trailing edges, and build the other half of the elevator. Cover both surfaces with rice paper.

Attach the elevator halves to the fuselage by means of two 1/32″ wires thrust through the body and projecting 1/2″ into the leading and center spars, and cement.

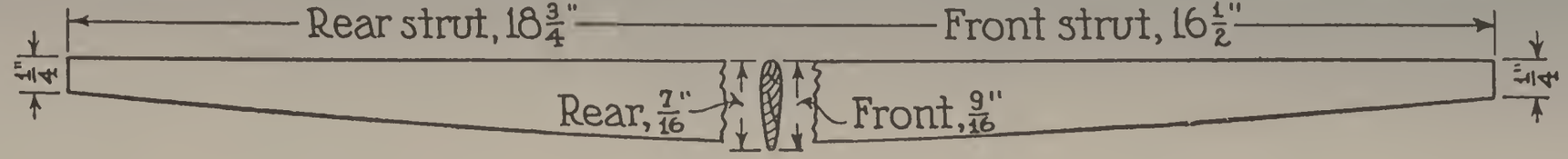
The rudder is much like a half-elevator. The lower rib,

however, is in two parts, the forward end inclining upward to fit the fuselage, and the rear half at 45 degrees with the center spar. Push a wire dowel into the end of the center spar end and the fuselage longeron, and nail the leading spar with a pin. Brace the rudder with a fine thread through the tip, connecting with the elevator tips.

Cement the wing to its cleat, further securing it with pins having $\frac{3}{16}$″ celluloid washers under the heads. Then make the two pairs of streamlined struts, cementing and pinning one end of each to the fuselage under the bulkhead and the other end to the wing, the front one under the third rib from the center, the trailing one 1″ beyond that rib.

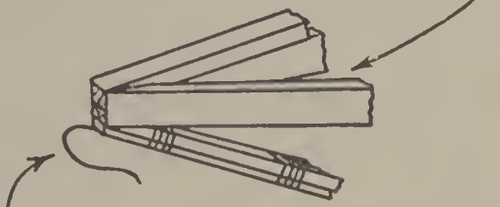
Test the plane on the level, casting it a little downward. The weight in the nose may need increasing, or the angle of the stabilizer may need changing.

This plane has a remarkably flat gliding angle. It will make excellent flights if launched from the hand on a hill side, but for real endurance and altitude it should be towed with a shock cord. Use two strands of $\frac{1}{16}$″ square rubber with a small metal ring tied at one end to go over the towing hook. With a boy to launch the plane, and one to tow it against the wind, it rises quickly. When enough elevation has been gained, the one towing should stop and twitch backward on the cord to release it from the hook.

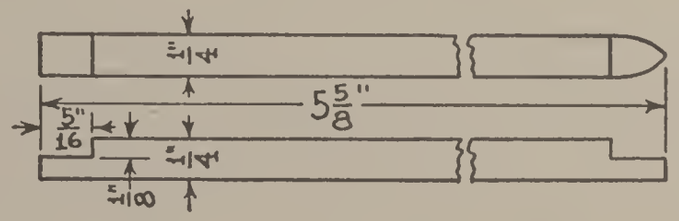


WING STRUTS

Cement together upper and lower longerons first

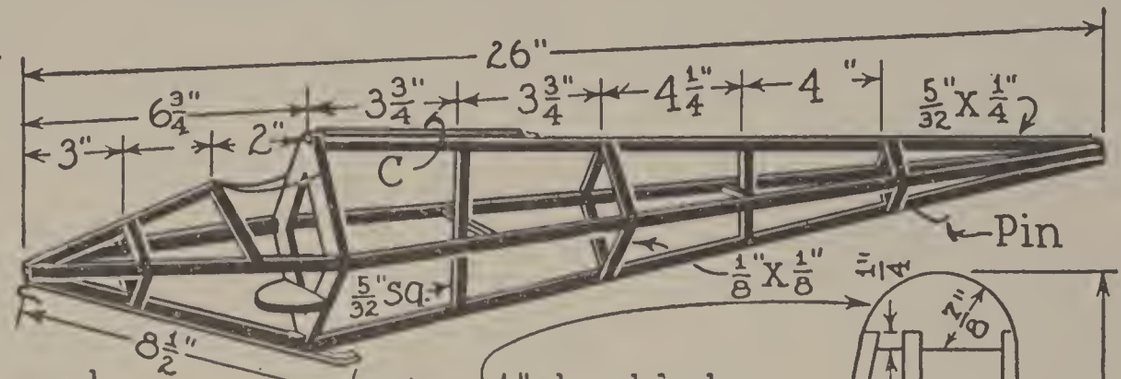


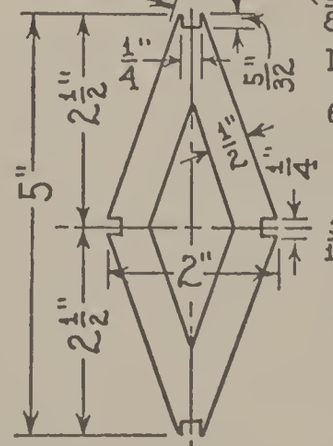
Tow hook is 1/32" music wire bound with thread to longeron and skid



WING CLEAT

Glue on upper longeron at "C"

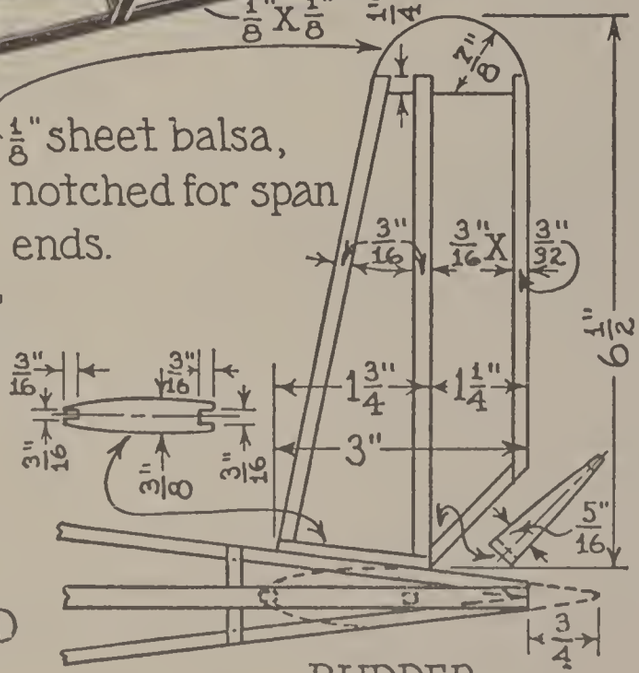




BULKHEAD

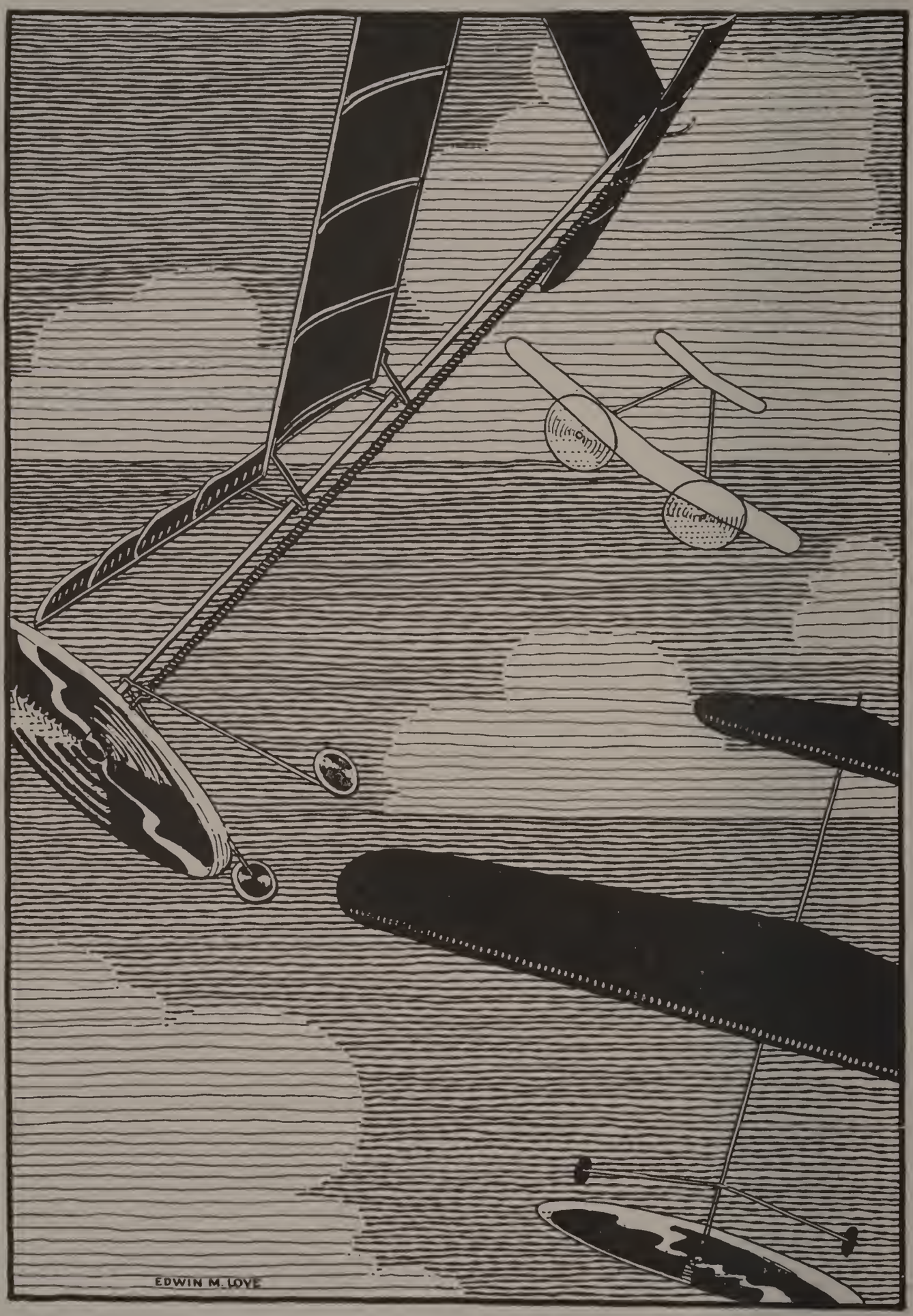
⅛" thick

⅛" sheet balsa, notched for span ends.



RUDDER

FUSELAGE DETAILS


EDWIN M. LOVE

PART II

STICK MONOPLANES

1

THE ROUGH AND READY TRACTOR

The *Rough and Ready Tractor* is a solid little plane, with wheels on the landing gear permitting it to take off from the ground. A staunch little flier it is. It whistles through the air in a steady climb, and if it perches in a tree or collides with a telephone pole, more likely than not it receives no other damage than a bent propeller shaft.

For this ship have the following materials: For motor stick, one piece of balsa $\frac{3}{16}$ by ¼ by 13¾″; for wing spars, ribs, etc., 6½′ of ⅛″ square balsa; for the propeller, a piece of ⅝ by 1 by 6″; for landing gear, etc., $\frac{1}{32}$″ music wire about 2 ft.; for propeller shaft bearing, a fine 1 or 1¼″ brad; rice paper 6 by 14″; for the wheels, stiff paper 1 by 4″; also thread, ambroid cement, wing dope, and 4 ft. of ⅛″ flat rubber.

To make the wing, cut two spars 13½″ long, and seven ribs 3″ long. Mark the spars for the ribs, spacing them 2¼″ apart, and cement them to the rib ends, the ribs lapping

above. When the cement is hard, glue rice paper over the frame, drawing it tight. Smear a thin coat of glue or paste on the wood, including all the ribs.

Partly break the spars at the center, coat the breaks with cement, and bend the wing so that the ends are 1″ above the center, blocking the part in that position for drying. The right end should be twisted slightly upward toward the front, so that the rubber motor will not whirl the plane.

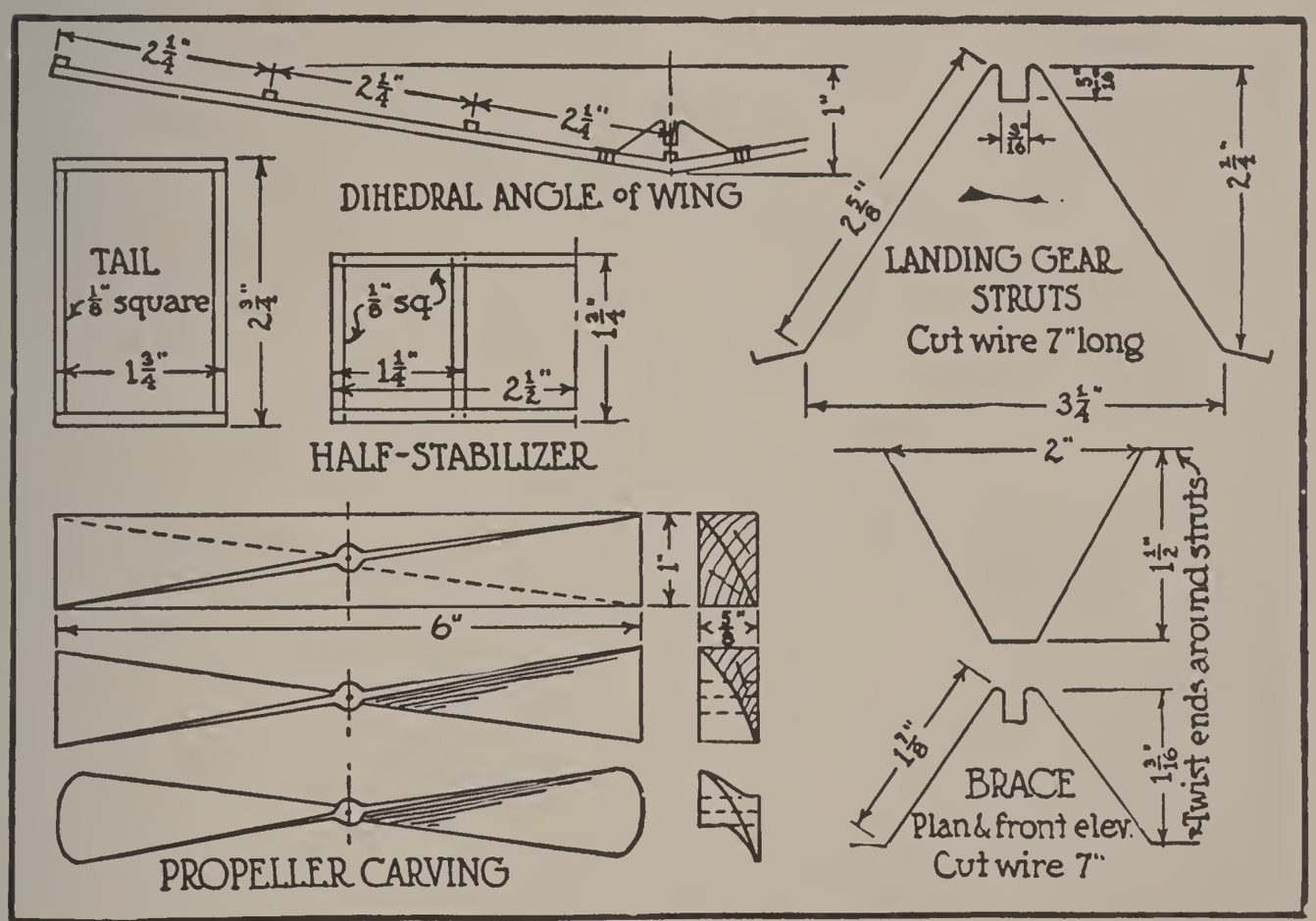
Bend the two wing stirrups as shown, so that the "U" centers will clasp the motor stick firmly. Cement the ends to the upper sides of the spars, and bind them with a few turns of thread.

The motor stick is sandpapered smooth, with the corners a little rounded. Make the tail hook as shown in the drawing. Push the other end through the motor stick 2″ from the rear end, sloping it backward, and bend the wire to form a skid. If the motor is to be wound by turning the propeller, slip over the hook a bit of rubber tubing; but if a winder is used, make an "S" hook to join the rubber with the tail hook, and put on the tubing.

Heat the brad red hot to soften it. Cut off the head, bend the nail around a piece of the wire, and ⅜″ from the

eye bend the point back nearly at right angles. Flatten this part by hammering, cement it to the forward end of the motor stick, on top, and wrap it with thread.

The stabilizer is made of two 5″ spars and four 1¾″ ribs. This is cemented across the under edge of the motor stick at the rear end, with the paper side down.



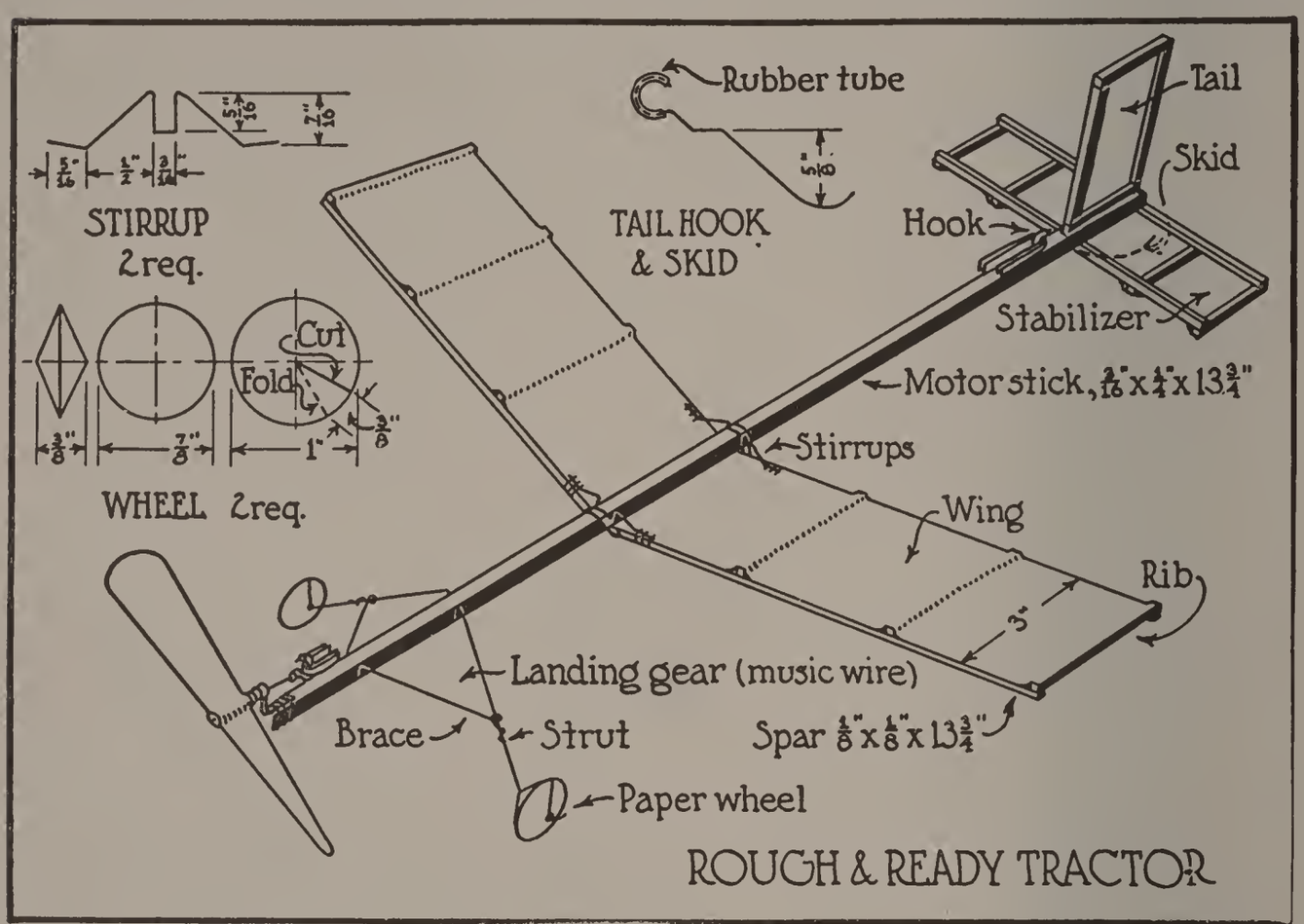
The tail, 1¾ by 2¾″, has two vertical spars glued between two ribs, with sides flush. It is covered on one side with paper, and is cemented to the top of the motor stick, over the elevator.

Paint all paper covering with wing dope.

Lay out the propeller carefully. Draw diagonals on both faces, and circles at the centers. Saw along the diagonals,

leaving a little wood each side of the marks to strengthen the hubs, and whittle the backs of the blades. Sand them smooth, a little hollowing, before carving the fronts. When well shaped, trim the corners of the tips round.

Bend a ¼″ hook on a piece of wire, leaving a straight



shaft 2″ long. Press the end through the propeller hub, bend over the end, and cement.

Before adding the rubber tubing to the hook, slip on two glass beads for thrust bearings, and put the hook through the brad eye.

The landing gear struts are bent up as shown, so as to clasp the motor stick as do the wing stirrups. As they spring apart a little when carrying the weight of the plane, the

wheel spindles are bent downward somewhat at the ends, so that, when standing on the ground, the wheels will be upright. The struts are pressed on the motor stick 3″ from the front end.

Make the brace. It clasps the stick 1½″ in front of the struts, and the ends wrap around the struts about halfway down.

To make the wheels, cut four 1″ circles from stiff paper, and cut each radially to the center. Fold a little ⅜″ from the cut, spread glue on this flap, and close the cut edge over to the fold, pressing the flap behind. This makes a cone.

Cement two cones, at the edges, to form one wheel, and thread the strut ends through the centers. A little blob of cement each side of the wheel, on the wire, keeps it from slipping sidewise.

Put the wing in place on the motor stick, the front edge about 5″ from the front end. Loop a rubber over the motor stick before and behind the plane and under the wing, to prevent its working off.

Put on four strands of ⅛″ flat rubber, short enough to hang rather straight without being stretched. Before launching, wind the propeller backwards until two rows of knots are seen. If the ship settles on the tail, move the wing back a bit; and if it nosedives, move it forward.

2

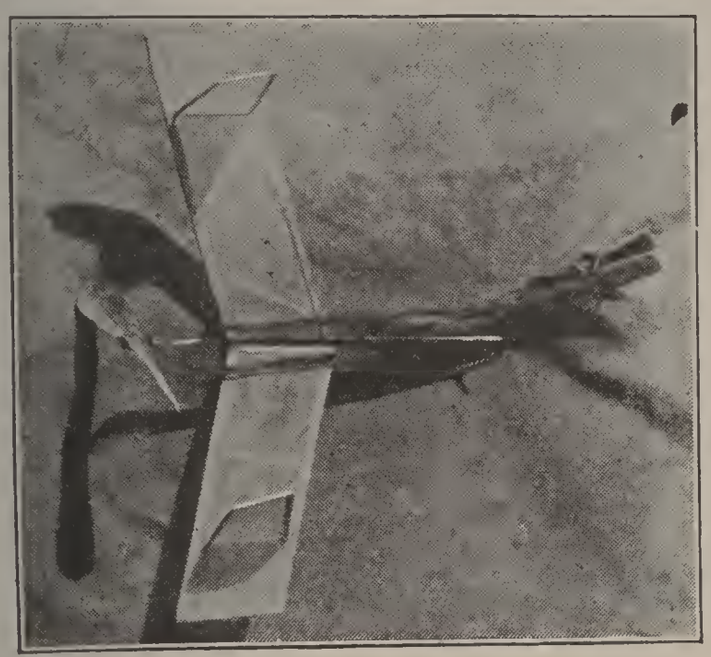
THE TUMBLE BUG

The *Tumble Bug* is a little tailless plane, and a pusher. A regular clown it is, for it just can't behave. It darts away from the hand of the launcher, looping and zooming, circling and zig-zagging, as likely as not returning to give a peck at one's head. If a thrilling flight is wanted, this plane is certainly the one to give it.

To build the *Tumble Bug,* these materials are needed: One piece of balsa $\frac{3}{32}$ by $\frac{3}{16}$ by 7″; for the wing, $\frac{1}{16}$″ balsa ¾ by 12″; for the propeller, balsa ½ by ⅝ by 4¾″; for the shaft, etc., $\frac{1}{64}$″ music wire 8″ long; also two small washers, a glass bead, ambroid cement, wing dope, rice paper 3 by 15″, and 14″ of ⅛″ flat rubber. For the bearing, have a piece of aluminum $\frac{1}{32}$ by ⅛ by ⅞″.

In laying out for making the wing, draw on a board two lines 2¼″ apart, and a third 1⅞″ from the second. Square a center line across them, and 5½″ each side make two other lines. From the $\frac{1}{16}$″ balsa split off two spars $\frac{5}{32}$″ wide. Cut two halves for the front spar, fitting them together to sweep back from the center at the first line to the second at the ends. The rear spar sweeps back from a point

at the center 2⅛″ behind the leading spar, to the back line



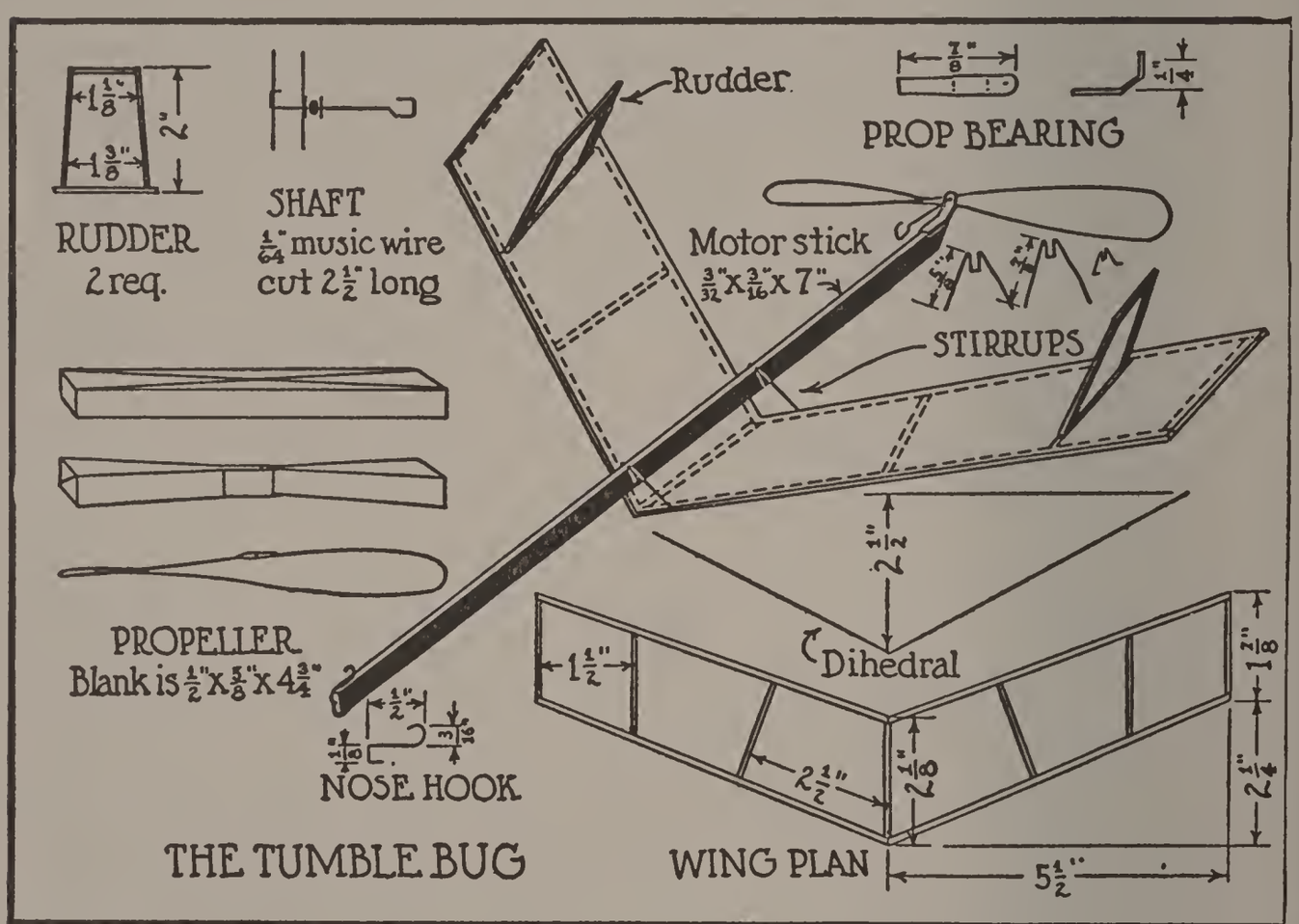
at the ends. Cement the center ends, and ambroid a $\frac{1}{16}$ by $\frac{3}{32}$″ rib there. Also cement ribs between the ends. When nearly dry, bend the spars at the center until a dihedral angle 2½″ deep is formed. Cement again, and let dry. Finally cover the upper surface with rice paper glued both to the spars and the ribs, but do not dope yet.

Two rudders are to be made next. The detail in the drawing clearly shows their form. They are 2″ high, 1⅛″ wide at the top, and 1⅜″ at the bottom. The frames are of $\frac{1}{16}$ by ⅛″ balsa, with the top butted between the sides, and the sides butted against the lower rib. The lower ribs are cut long, so that they can be fitted between the rib spars. Cover them on one side with paper.

Draw a pencil line 1½″ from each end, and parallel to it, on the wing. Carefully slit the paper along this line. Fit the rudders between the spars at these points, coat the sides and ends of the lower ribs with cement, and glue the tails in place. Be sure to get them parallel to each other, and upright in relation to the wing. Paste the wing covering neatly to the lower ribs. When dry, dope the paper. Twist

the right end slightly to prevent the motor rubber from turning the plane over sidewise.

Now smooth the motor stick and round the lower end-corners. Bend a nose hook as shown, push one hook into the front end of the stick, where it is cemented, and drill



the aluminum bearing with a hole just large enough for the music wire propeller shaft. If you have no #60 drill, flatten the end of a fine brad, file a point on it, cut off the head, and use it in place of a regular drill. Bend the bearing end up, and trim the rest to fit the top of the motor stick. Cement it there, giving it two or three coats to make sure it sticks. Sand the stick corners round.

Bend the wing stirrups next. Fit them to the motor stick, making the legs of the front one 5/8" long, and those of the rear, 7/8". Bend the ends at right angles for points to go into the spar edges of the wings. Be sure to get the short one in front, and cement well.

The propeller is true pitch. Draw diagonals on the faces of the balsa blank, and draw hub lines 1/8" apart at the center to meet the diagonals. Carve the insides of the blades first, then the outsides, reducing the thickness to less than 1/8". Round the ends and edges, and sand smooth.

Cut the shaft 2½" long. Bend a rubber hook on one end, thrust the straight shank through the propeller hub, from the front, and bend the end into a hook to push into the hub. Cement the wire.

Thread a small washer, a bead, and another washer over the shaft, before putting the hook through the bearing.

Two strands of 1/8" flat rubber are needed for the motor. Tie the ends together to form a loop 1/8" longer than the distance between hooks, pull the knot hard, and trim the ends close. Put the knot at the front hook.

Adjust the plane for a rather steep glide, pushing the wing back if the plane sits on its propeller, and forward if it goes into a nosedive. Wind the propeller backwards until one row of knots appears in the rubber, and try a flight. After the rubber has been used a few times, wind it until a scattered row of third knots appears.

It may be necessary to twist the rudders to get a good flight, and this can be done by grasping the upper ribs with the fingers. If the joints are loosened, cement them with the proper twist.

With a little care, the plane can be made to fly straight, but the flight is more thrilling if it darts around in circles and makes loops. The latter are caused by moving the wing slightly forward of the level flying position.

If it is desired to use a winder for the plane, make an S-hook to hold the front end of the rubber and to loop into the front hook. The rubbers, of course, will need to be shortened a little. Talcum powder rubbed on the strands, or an even coat of glycerin, lubricate them and keep them from chafing when tightly wound.

3

A HYDROPLANE TRACTOR

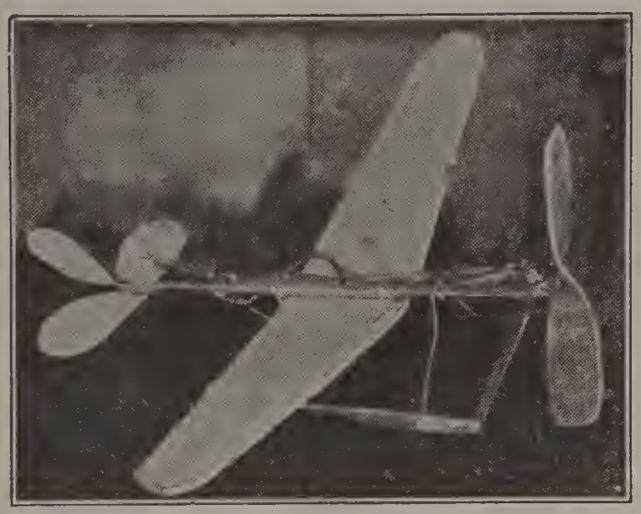
This brisk little hydroplane takes off from the water and hums through the air in a very business-like manner; but it can be flown from the hand, on land, just as well. After all next to building it, the pleasure of having an airplane model consists in seeing it fly.

For materials, have the following: For motor stick, one piece of soft balsa 1/8 by 3/16 by 11″; for wing and pontoon, 3/32″ veneer 1/2 by 12″; for propeller, a piece 1/4 by 1 by 6″; for tail assembly, hooks, etc., 1/64″ music wire, 4 ft. long; for bearing, aluminum 3/64 by 1/8 by 1/2″; also rice paper, 6 by 12″, ambroid cement, wing dope, light wrapping paper, shellac, fine thread, and 42 inches of 1/8″ flat rubber.

To make the wing, draw the outline on the work table or a flat board. Make a rectangle 3 by 13″, dividing it in the center. Measure from the front edge 1/2″ back on the ends for the leading spar, and place points 1 3/4″ farther back for the trailing spar. Connect these lines with the center ends, and the main shape of the wing is determined.

Cut the spars from 3/32″ balsa as 1/8″ strips. Sand them to 1/16″ thickness at the ends, tapering from the centers. Also

taper the width to $\frac{3}{32}$" at the ends. Break the spars at the center, place them on the pattern, and cement the breaks. Trim the ends ¾" from the pattern ends. The three ribs are $\frac{1}{16}$ by ⅛". Glue them on top of the frame. When dry, lift the frame and cement and tie the music-wire tips, finishing the wing with neat curves.



This dry, crack the spars at the center and bend the wing into a dihedral 1½" deep. Cement, and block until dry.

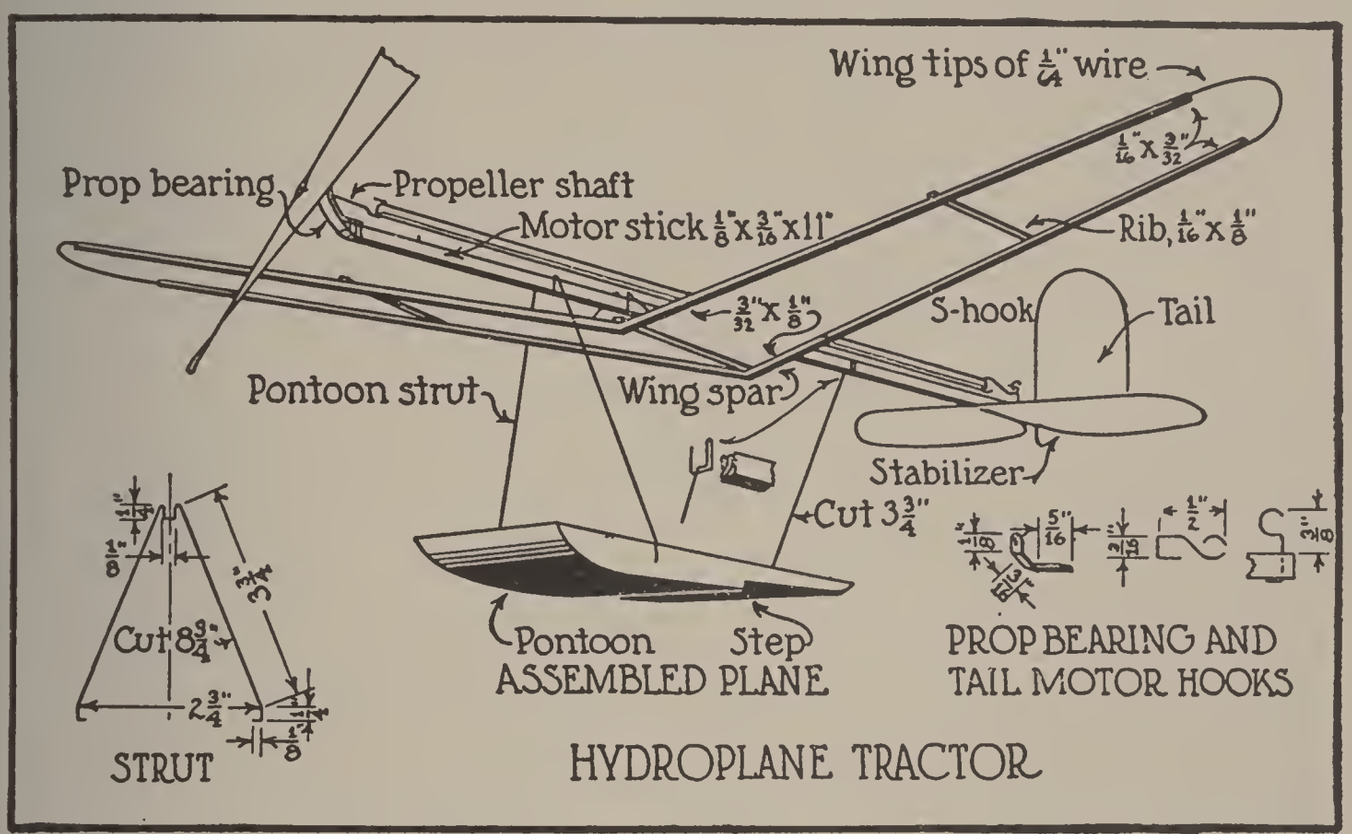
Now cover the upper side with rice paper and dope, and twist the left wing while drying, to oppose propeller torque.

The stirrups are shown in the drawing. Bend the ends to fit the dihedral, and make the front stirrup ⅛" shorter than the hind, so as to give the necessary angle of incidence to the wing. Cement these clips to the upper sides of the spars.

The tail is a single piece of music wire bent as shown, with paper cemented on one side. Notice that the ends of the frame cross. The horizontal end is thrust into the motor stick and the vertical end is cemented to the end.

The stabilizer also has a single-piece wire frame. Cover the under side with rice paper.

For pontoon sides cut pieces of $\frac{3}{32}$″ veneer ½ by 4″. Notch the upper corners $\frac{3}{32}$″ square, to receive the ends of the cross pieces. Round the forward under edge. Notch the step 2½″ from the fore end, tapering the hind part a little and ending with a curve. Sand to $\frac{1}{16}$″ thickness.



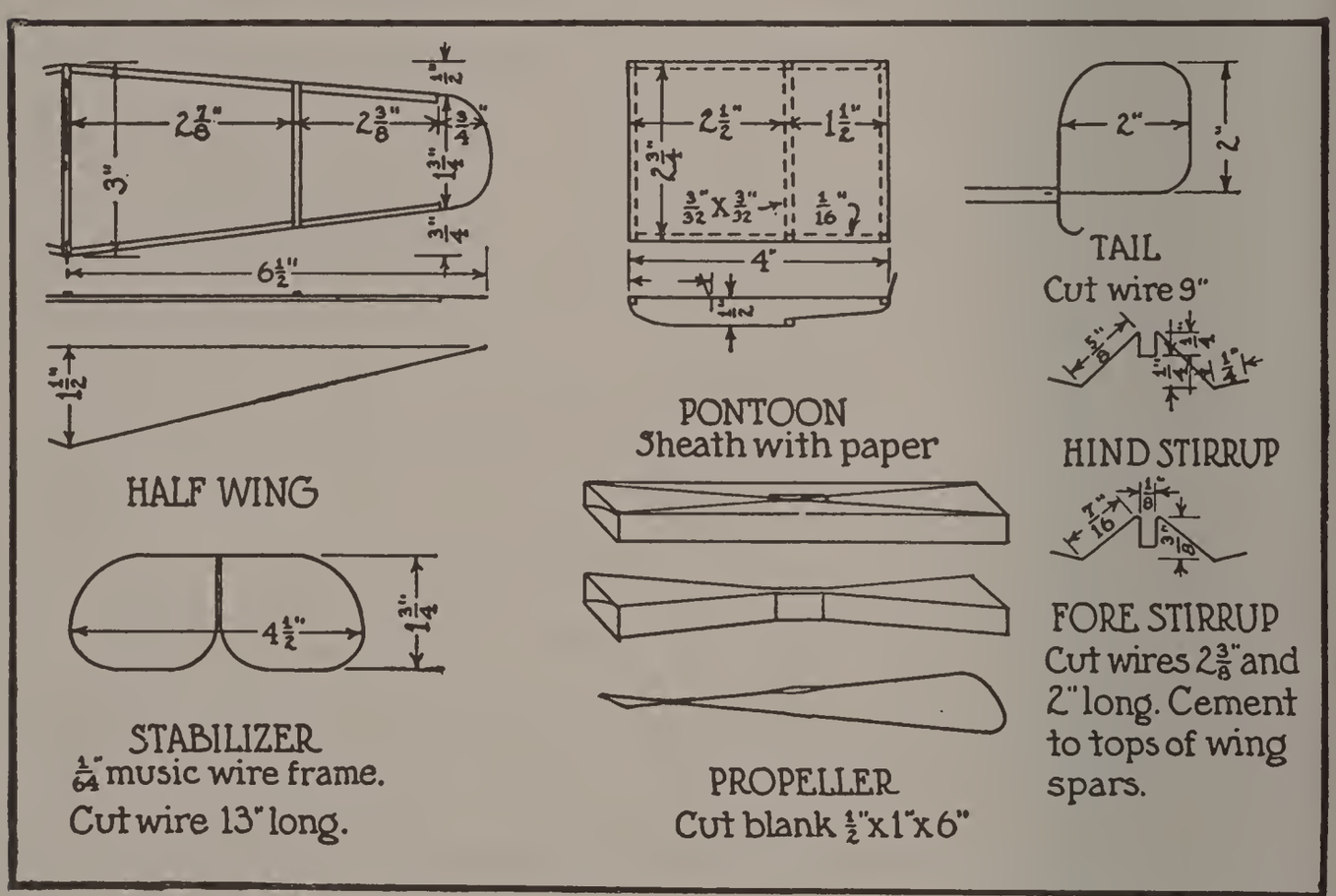
The cross pieces are $\frac{3}{32}$″ square and 2¾″ long. Cover the pontoon with thin wrapping paper, and shellac it.

In bending the struts, be sure the upper clips are narrow enough to grip the motor stick firmly. The lower ends are bent at right angles, to stick into the pontoon sides, where they are cemented. The rear strut attaches to the center of the back crosspiece.

Sand the corners of the motor stick, and glue the stabilizer and tail to one end. Twist the stabilizer down in front

until the leading edge is a little more than $\frac{1}{16}$" lower than the rear. Bevel the under side of the front edge to meet the bearing, to reduce air resistance.

For the bearing, drill a #60 hole in one end of the aluminum, bend $\frac{1}{8}$" of that end at a little less than 45 degrees. Bend the base another 45 degrees, $\frac{3}{16}$" from the first bend, and cement and tie to the top of the motor stick.



Attach the wing to the stick about half-way back. The pontoon front struts attach about 3" from the bearing, and the hind strut far enough back so that, when the plane rests on the pontoon, the front end is 1" higher than the stabilizer.

Bend a tail hook, push the end through the stick, and bend under. Cement it.

Carve the propeller from a ½ by 1 by 6" blank. Draw lines from corner to corner, and a couple of lines ⅛" apart at the center, for the hub. Carve the blades flat, then hollow the backs and round the fronts, to a thickness of $\frac{1}{16}$".

The propeller shaft is cut 2½" long. Bend a hook on one end and push the other end through the hub, bending it into a hook which is pushed into the wood. Slip on three thin washers before putting the shaft through the bearing.

Make an S-hook for use with a winder, and install a four-strand ⅛" flat rubber motor, allowing ⅛" slack.

Now for flying. Adjust the wing for a good glide without power. Mark the position. Wind the prop backwards until the second row of knots begins to show, cast the plane light forward, and if it stalls, bend the bearing forward a little, so that the propeller pulls downward more. If the plane nosedives, bend the bearing more vertical.

To take off from the water, wind and set the ship on the water, letting go of the stick and prop at the same time. If the propeller pulls down into the water, dry the wing, and move the pontoon forward a little. It will be necessary, of course, to readjust the wing position for a good glide, and perhaps, as well, the angle of the bearing.

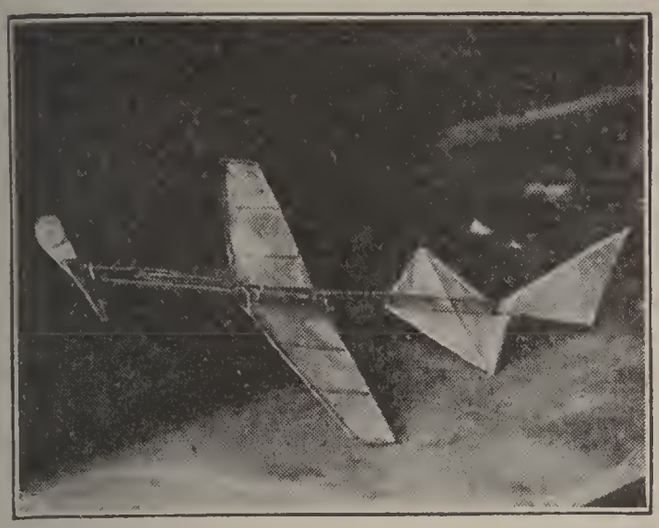
4

THE FLYING FEATHER TRACTOR

This little plane is truly a feather-weight, for with two strands of rubber for outdoor flying, it weighs less than 1/5 ounce, and if it is powered with one strand, for indoor flights, it is still lighter. And how it flies! It reaches a good elevation, and holds a level after the motor is nearly unwound.

Materials needed are: For wing and stabilizer spars, two pieces of $\frac{1}{16}$ by $\frac{3}{32}$ by 14″ balsa; for ribs, one piece of $\frac{1}{32}$ by $\frac{1}{16}$ by 14″; for tail, one piece of $\frac{1}{32}$ by $\frac{3}{64}$ by 11″; for the motor stick, one piece $\frac{3}{32}$ by $\frac{5}{32}$ by 12″; for the propeller, one piece ½ by ¾ by 5″; for shaft, skid, etc., music wire about $\frac{1}{64}$″ in diameter and 12″ long; 1″ of rubber tubing to fit wire hooks; rice paper, 6 by 14″; ambroid cement, wing dope, thread, and two ft. of ⅛″ flat rubber.

Build the wing first. Draw the pattern on a flat board. Lay over it a piece of waxed paper, to prevent glue from sticking the frame to the board. Drive a brad inside the spar centers and outside near the ends, and bend the spars around them. Simply glue the rib ends on top, without any attempt to butt them between. When dry, trim off all ends with a razor blade.



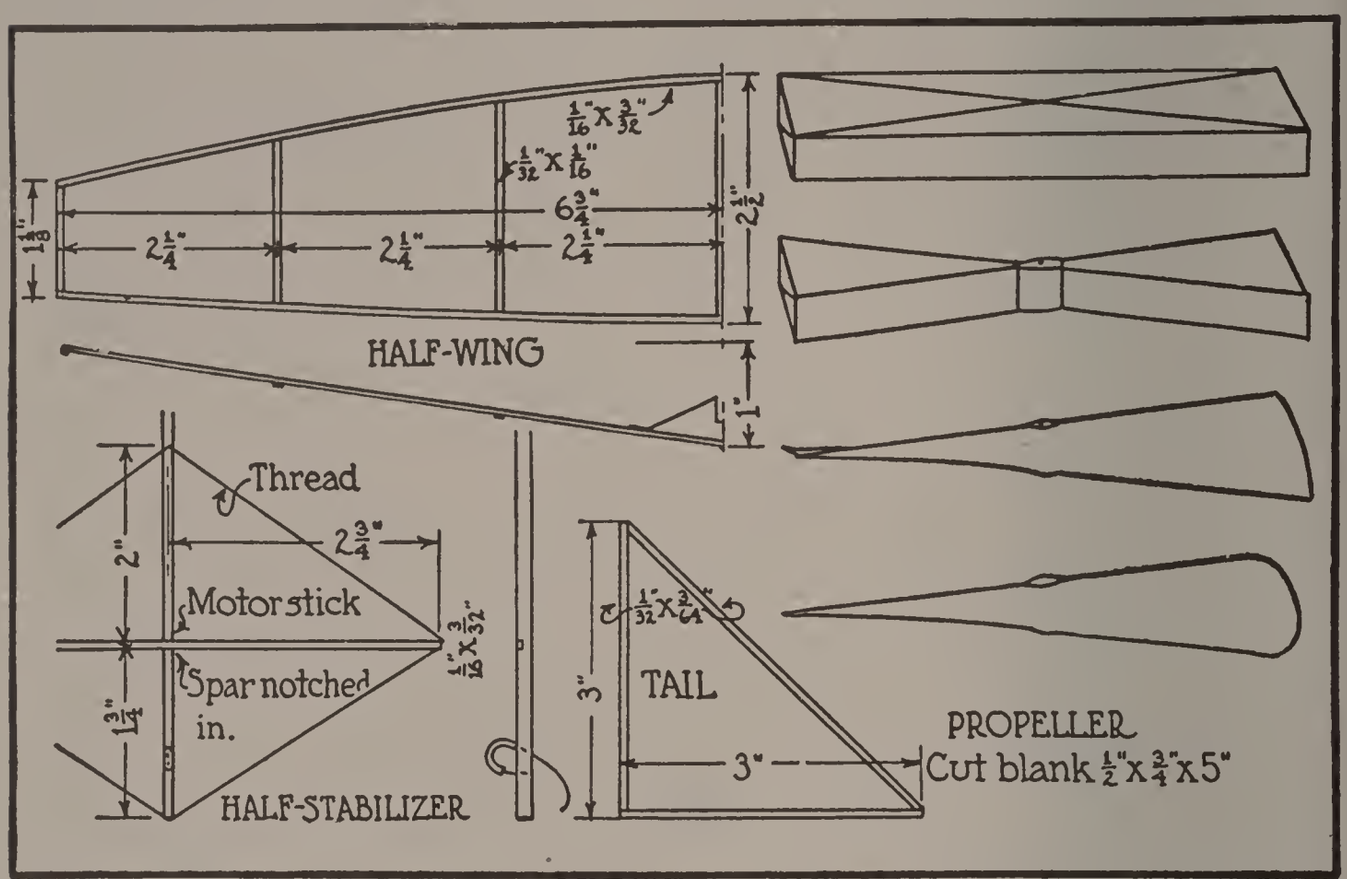
Cut the paper a little larger than finished size. Smear glue thinly on the spars and ribs. Press the paper on, stretching it as smoothly as possible, and trim to the frame when dry. A coat of dope completes it. While drying, it should be propped so that the right end is twisted downward a little, to overcome propeller torque.

Smooth the motor stick with fine sandpaper. Make a propeller bearing of wire, by cutting a piece 2″ long and bending it around a coarse needle, in the middle, until the two legs lie side by side. Squeeze the wire together beneath the needle with pliers, bend the legs back nearly at right angles with the eye, ⅜″ below, and then bend the ends down again. Pull out the needle, straddle the ends over the motor stick, bind the middle part to the top with three or four wraps of thread, and cement.

The tail hook and skid are one piece of wire 2″ long. Push the wire through the motor stick, from top to bottom, inclining forward, about ¾″ from the rear end, slip ½″ of rubber tubing over it, and bend the end back so that it can be thrust squarely through the stick. Bend the lower end in a curve for a skid.

Cut a notch in the upper edge of the stick 1¾″ from

the rear end, and glue into it the stabilizer spar. Cut the ends off 2¾″ from the center. Stick a pin in the motor stick 2″ from the front of the spar, glue the end of a thread to the rear end of the stick, and stretch it around the spar

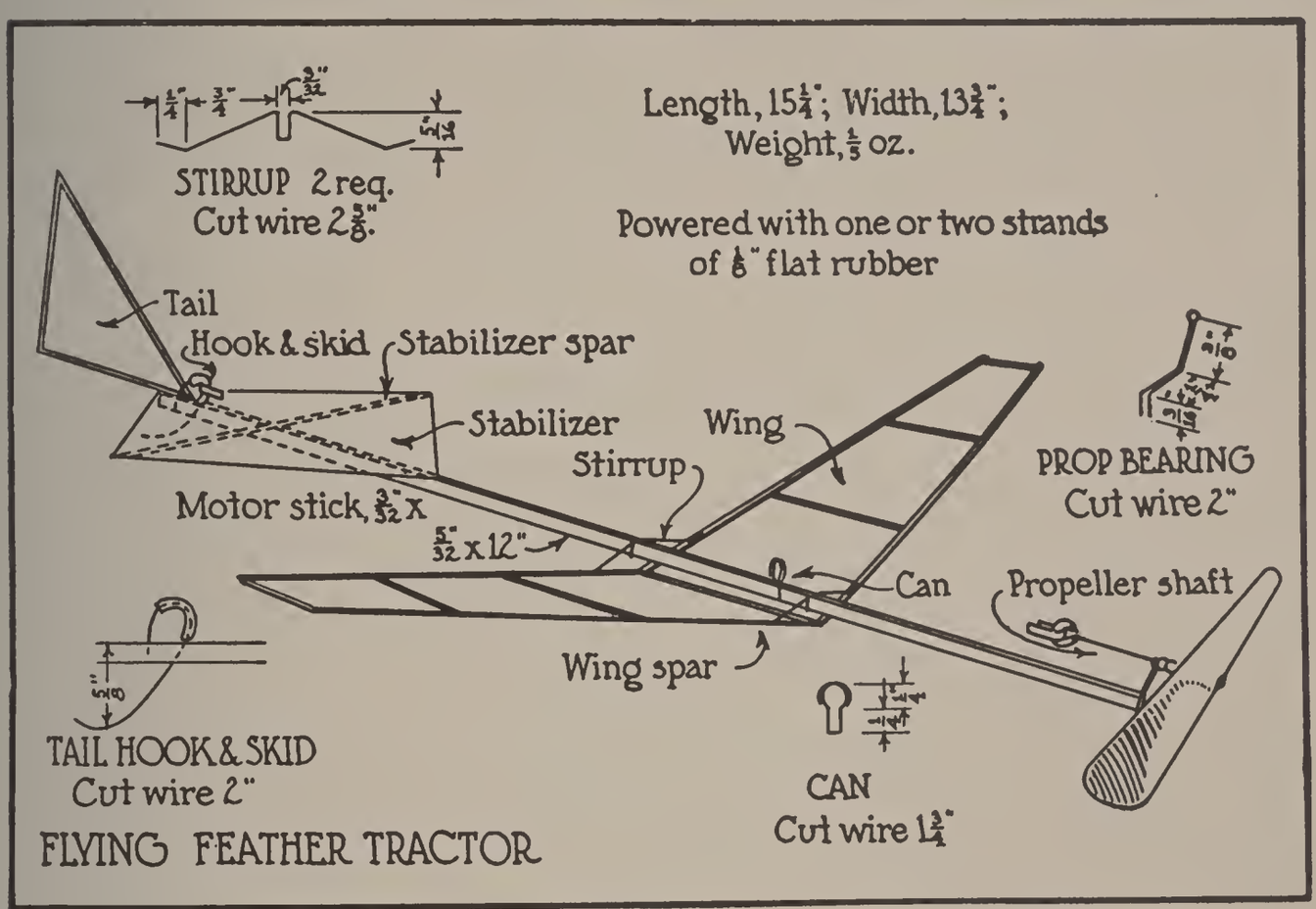


end, the pin, the other end of the spar, and back to the stick. Square the spar with the stick before gluing the thread.

When all is dry, pull out the pin and glue a piece of rice paper on the top. Trim the edges in the same way as with the wing. The paper is slit to slip over the motor hook.

The tail is simply a right-angle triangle 3″ wide and 3″ high, covered on one side with paper. The front point is glued to the stabilizer and hook, and strengthened with a few wraps of thread.

Now bend two wire stirrups for the wing, as shown in the drawing. Gently crack the wing spars over the center rib, cement them, and prop the wing with the tips raised 1″ for the dihedral angle. When dry, cement the stirrups in place, and slip them over the motor stick, with the wing a



little more than half-way back between the front end and the stabilizer.

The propeller is carved from a ½ by ¾ by 5″ balsa block. Draw diagonal lines on each face, saw nearly to the center, leaving ¼″ for the hub, and whittle the inside faces of the blades. Sand them smooth, and a little concave. Then carve the front faces. Thin the blades until light can be seen through them. The corners should be rounded.

Using 2½" of wire for the propeller shaft, bend a small hook on one end, slip rubber tubing over it, and press the other end through the propeller hub. Bend the tip at right angles, coat it with cement, and put it back against the prop. Slip two glass beads over the shaft before putting the hook through the bearing.

The rubber is looped around the prop hook and tied together after being passed through the skid hook. It should be just long enough to hang straight between the hooks without stretching.

For the trial flights, wind the propeller backwards until a row of knots appears in the rubber. Launch the ship pointing slightly upward. Move the wing forward or backward until the proper balance is obtained, and then wind until three rows of knots have come.

If a winder is to be used, do not attach the motor to the tail hook directly, but use an "S" hook between, so that it can be easily removed.

If the rubbers spring the motor stick too much, make a wire loop or "can" to put about half-way back, threading the rubber through it.

5

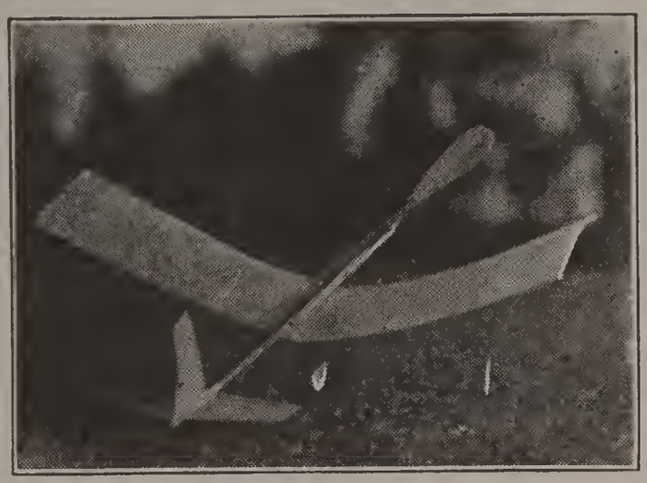
THE MAYFLY INDOOR TRACTOR

The *Mayfly Tractor,* for all the world like some dainty white-winged insect, flutters lightly through the air, and though so small, stays up a surprisingly long time. It flies well indoors, and if there is no wind or only a soft breeze, out of doors as well.

For the wings, a piece of $\frac{1}{16}$″ balsa ⅞″ wide and 16″ long is needed; for the motor stick, a piece $\frac{3}{32}$ by $\frac{3}{16}$ by 9″; for the propeller, balsa ½ by ⅝ by 7″; for the bearing, hard aluminum $\frac{1}{32}$ by ⅛ by ⅞″; for shaft, clips, etc., $\frac{1}{64}$″ music wire 12″ long; also rice paper 3 by 20″, ambroid cement, thread, a couple of small washers, a bead, and 9″ of ⅛″ flat rubber.

Split from the $\frac{1}{16}$″ balsa two wing spars $\frac{1}{16}$″ square. Lay them on a board, holding them with pins at the edges so that they measure 2¼″ from outside to outside. Cut them to a length of 14″. Also cut from the veneer a 2″ length of balsa to be used in making wheels. Then cut ribs, making them $\frac{1}{32}$ by $\frac{1}{16}$ by 2⅜″. Roll the under sides with a pencil to give them camber, remembering that most of the curve is near the front end. When they bend about ⅜″, miter

the ends and cement them to the upper sides of the wing spars, where they are allowed to dry before more work is done on the wing.



While the wing dries, make the stabilizer in the same way, using $\frac{1}{16}$ by $\frac{1}{16}$ by 4″ spars, and ribs cut $\frac{1}{32}$ by $\frac{1}{16}$ by $1\frac{5}{16}$″. The ribs are rolled full length with the pencil, giving them a curve throughout, approximately the arc of a circle.

Break the wing spars at the center, so that the tips can be raised 2″, forming the dihedral angle. Cement the breaks and dry them, then cover the upper side with rice paper, half the wing at a time, spreading thin ambroid or mucilage on the end and center ribs, and the outer edges of the spars. Draw the paper as smoothly as possible.

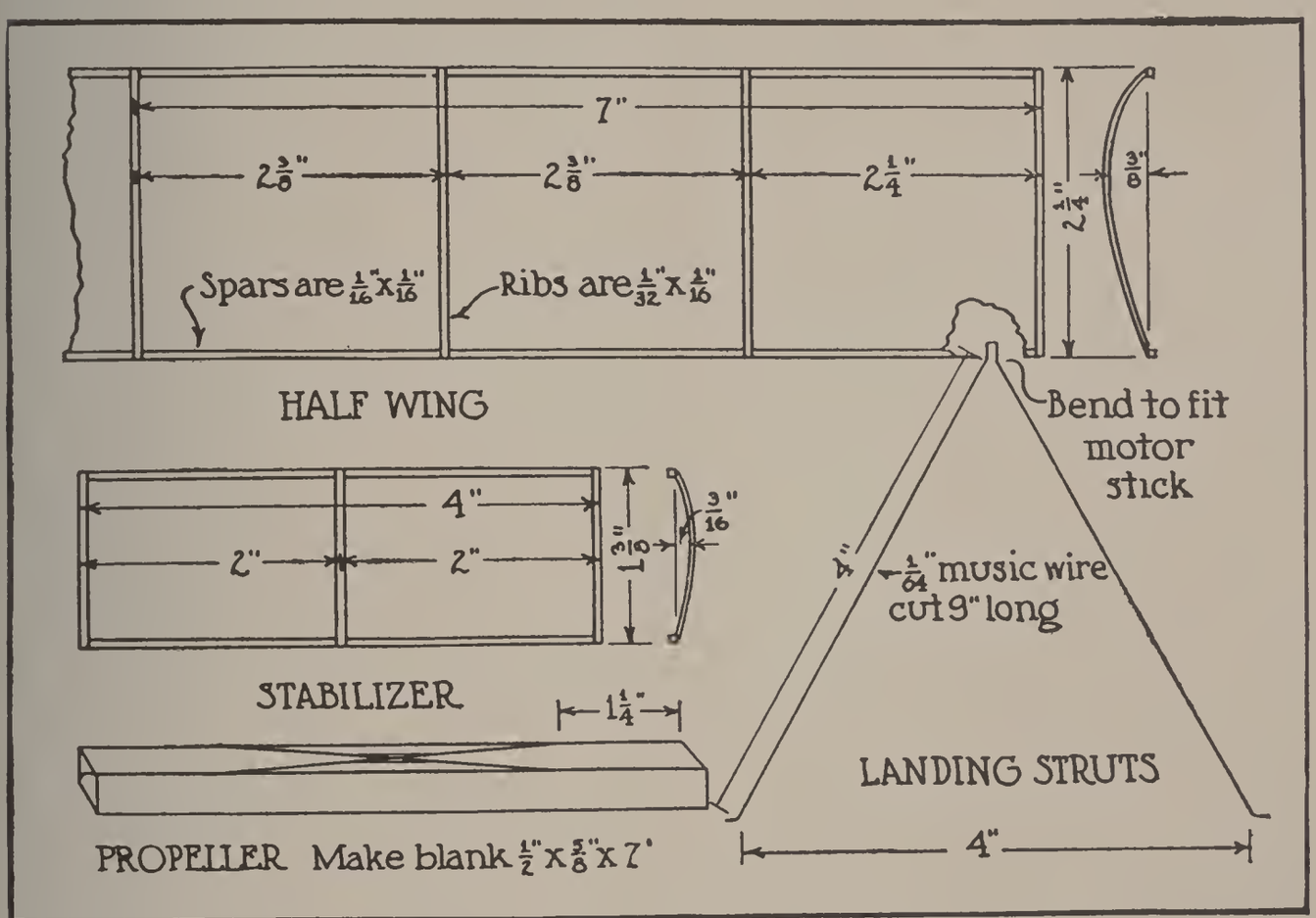
Cover the stabilizer with one piece, drawing the paper over the convex lower side. Trim the paper to the frame when the glue is dry.

The tail frame has a base rib $\frac{3}{64}$ by $\frac{5}{64}$ by $1\frac{3}{4}$″. The side and top pieces are $\frac{3}{64}$ by $\frac{1}{16}$″, making the tail $1\frac{1}{8}$″ wide at the top, $1\frac{3}{8}$″ at the bottom, $1\frac{1}{8}$″ high in front, and $1\frac{1}{4}$″ high on the trailing edge.

Smooth the motor stick and miter the front end, as shown in the bearing detail. Trim the lower edge of the

rear end to a slight taper, so that when the projecting end of the tail base rib is cemented to it, the rib will point a little downward in front.

Bend a short S-hook of $\frac{1}{64}$" music wire, and press one hook into the rear end of the motor stick. The other hook rests on top of the stick to carry the end of the rubber.



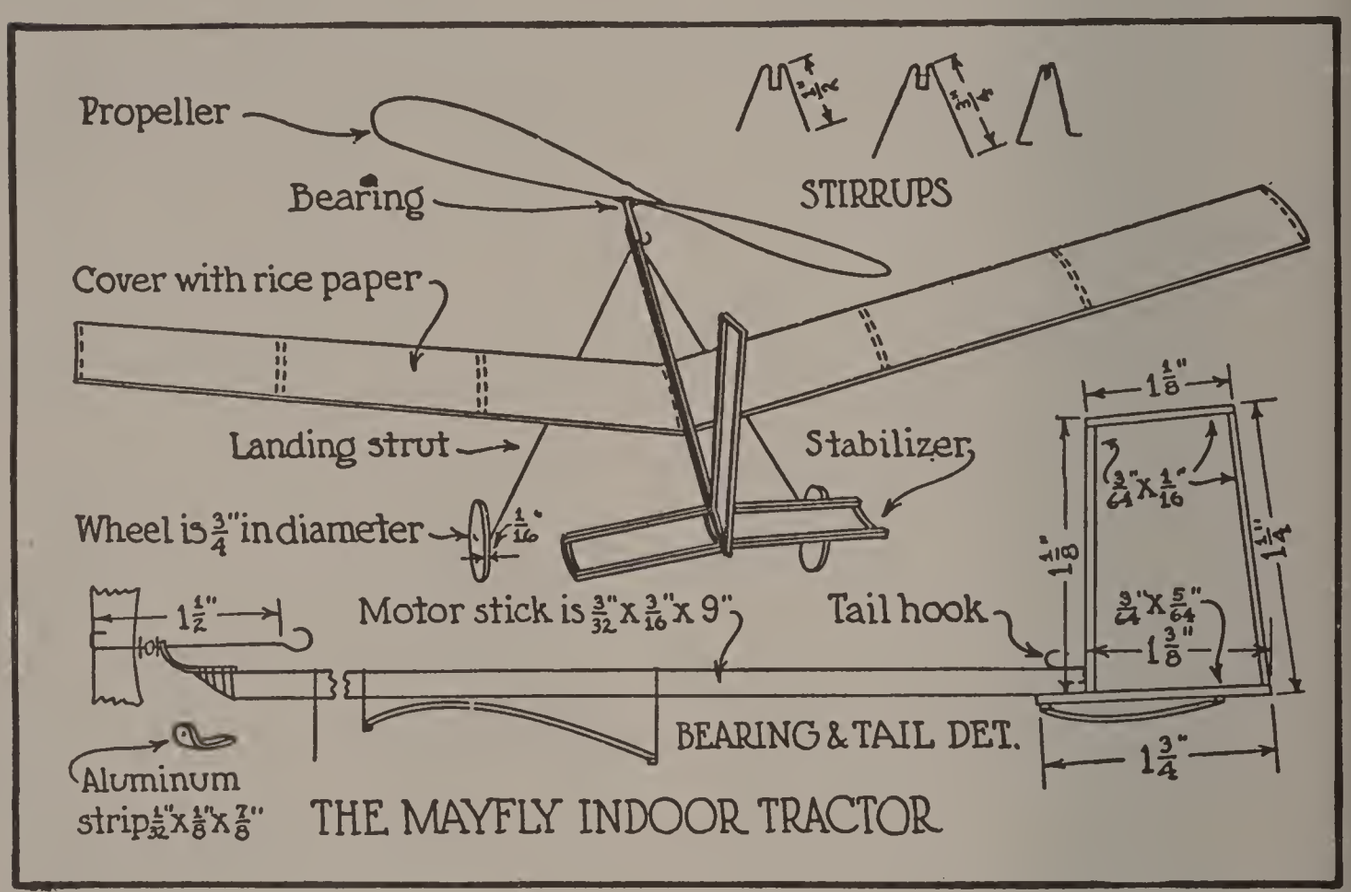
Cement the tail in place, and glue the stabilizer to the under side, hollow side up.

Drill the piece of aluminum to fit the wire, ⅛" from one end. Bend this end nearly at right angles to the rest and ambroid to the top of the free end of the stick. Bind it with a few turns of thread.

For the landing struts, cut a piece of music wire 9"

long, bend it into a clip at the center to fit around the motor stick, and bend the ends out so as to serve for wheel spindles. Cement the wire about 1″ from the nose of the motor stick.

The wheels are of $\frac{1}{16}$″ balsa, and are ¾″ in diameter.



Mount them on the ends of the landing gear struts and cement them fast. They do not need to turn.

In laying out the propeller for carving, draw diagonal lines from points on the edges of the faces 1¼″ from the ends. Also draw lines parallel to the edges $\frac{1}{16}$″ each side of the center, for the hub. Trim the edges of the blank to this outline, and then carve the insides of the blades. They should be about $\frac{1}{16}$″ hollow. When smoothly sand-

papered, carve the fronts of the blades. Work carefully in this, and finish them less than $\frac{1}{16}$″ thick at the middle, or rather, forward of the middle, toward the leading edge. The thickness should decrease toward the edges. Trim the ends round, and cut in toward the hub until the thickness there, from front to back, is $\frac{5}{16}$″.

The prop shaft is cut 2¼″ long. Bend a hook on one end, push the other through the propeller, and bend a hook on that end to press into the hub, which will make it fast when cemented. Thread over it a thin washer, a bead, and another washer, before putting the shaft in its bearing.

The motor is a single strand of ⅛″ flat rubber, with holes in the ends pierced with a pin, to put the hooks through.

To attach the wing to the motor stick, bend two wire stirrups, one with the legs ½″ long, the other with legs ¾″ long. Cut the wire long enough to allow of ⅛″ being bent back at right angles to each leg. Cement to the undersides of the wing spars, the short stirrup in front, the long one behind.

Put the wing 3½″ behind the propeller, and try a short flight of the plane. Move the wing back a little if the tail rides low, or move it forward if the ship dives.

The *Mayfly* takes off from a smooth floor after taxiing two or three feet, and gains elevation quickly.

6

AN ENDURANCE STICK MODEL

Simple as it is, this stick model is a wonderful flier, both for altitude and endurance. It was built by Martin Moad, a Los Angeles school boy, and like all the planes he builds nowadays, is a splendid performer.

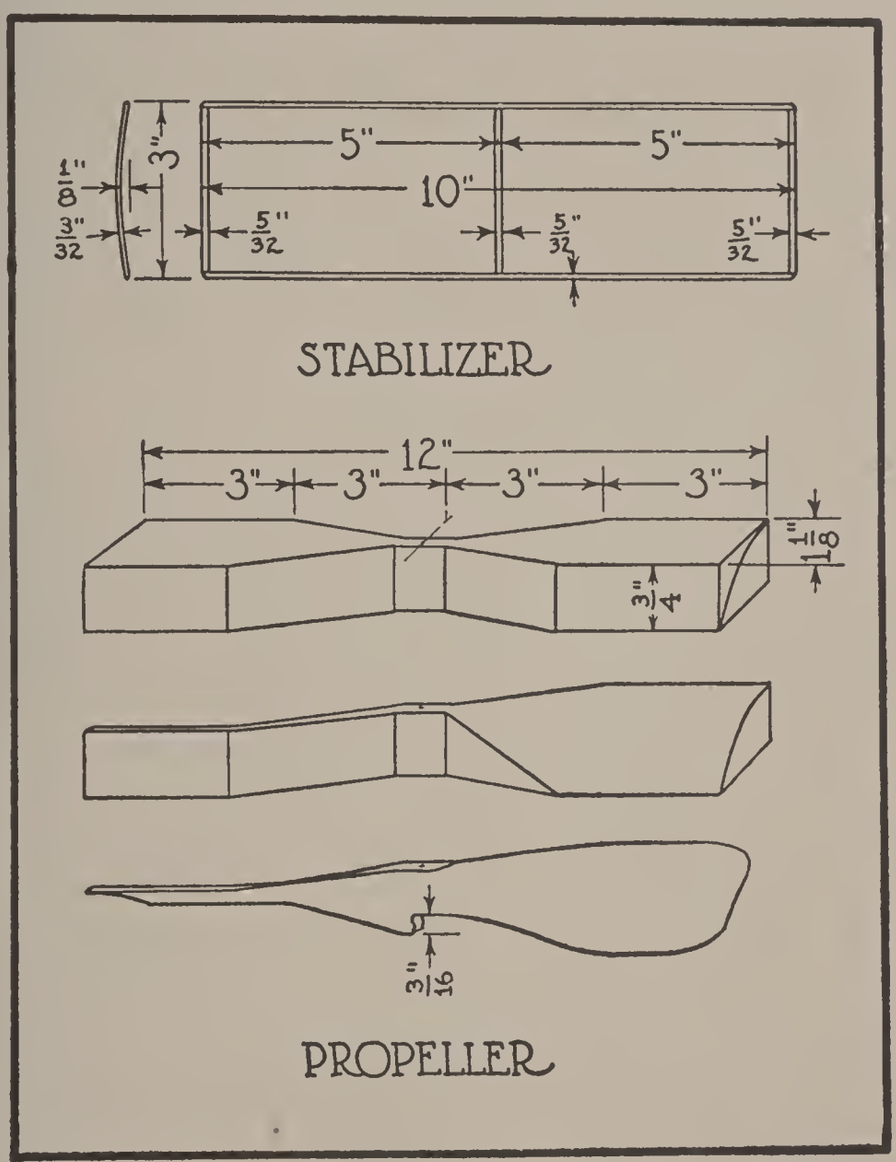
Have ready the following materials: For wings, tail, and stabilizer, three pieces of $\frac{3}{32}$ by ¼ by 30″ balsa, and one piece $\frac{3}{32}$ by $\frac{5}{32}$ by 30″; for motor stick, one piece $\frac{3}{16}$ by $\frac{5}{16}$ by 21″; for bearing, aluminum $\frac{3}{64}$ by $\frac{3}{16}$ by 1⅛″; also two pins, 15″ of $\frac{3}{64}$″ music wire, small, thin washers, or old kodak film to make them of; thread, rice paper 10 by 30″; ambroid cement, wing dope, and 12 ft. of ⅛″ flat rubber.

For wing spars sand smooth and round the corners of two pieces of $\frac{3}{32}$ by ¼″ balsa. Mark the centers and lay off for ribs centered 3¾″ apart.

Make the ribs $\frac{3}{32}$ by $\frac{3}{16}$″. Cut them a little more than 5″ long. Lay them on a pad of newspapers and roll the forward ends one-third of the way back with a lead pencil. This gives the camber, the amount of curve being regulated by the pressure on the pencil. Bevel the ends, and cement them to the spars. Trim the upper corners to meet

the spars, and round the wing corners. When dry, break the spars in the center and cement together with a dihedral angle 4″ deep.

Cover the upper surface with rice paper. Glue the paper to the leading edge, apply glue thinly to the upper



surfaces of the center and end ribs, and glue to the trailing edge. When the whole wing is covered, block it with enough twist to raise the leading edge of the left end ¼″ more than the other end of the wing, and dope.

Notice that the $\frac{3}{64}$″ music wire stirrups are made with

the points bent so as to thrust into the edges of the wing spars. The fore clip, being shorter than the hind, lifts the leading edge about ¼", which is a good climbing and gliding angle.

The stabilizer has two spars and three ribs, all made of $\frac{3}{32}$ by $\frac{5}{32}$" balsa. The ribs, however, instead of lapping over the spars, as in the wing, butt between. They are rolled full length with a pencil, so that they are arcs of circles bulging ⅛". Cover the under side with rice paper.

Sand the corners of the motor stick and round the under edge of the fore end, to reduce air resistance.

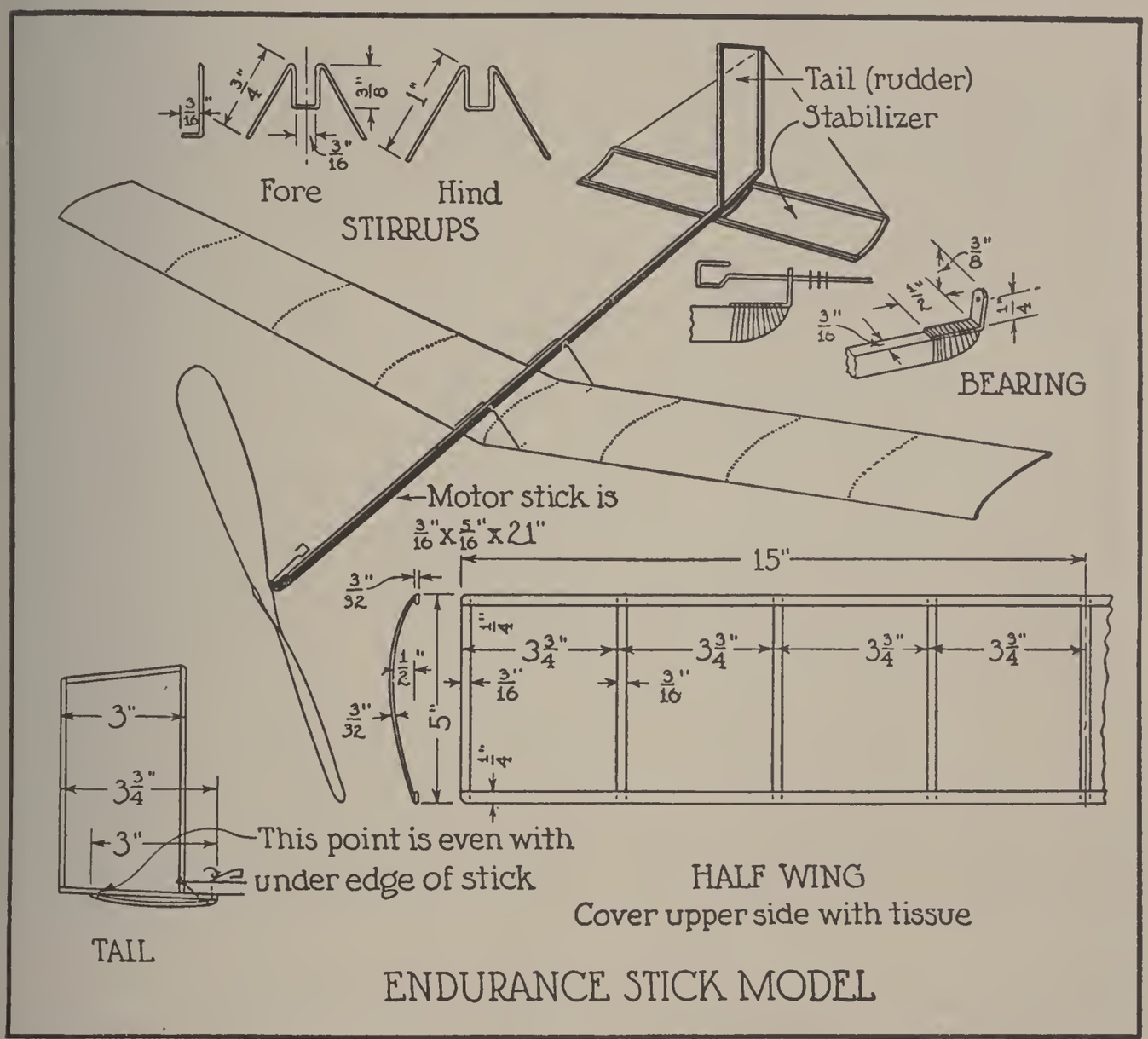
Shape the aluminum bearing. If you have no drill of a size to fit the wire, hammer a flat point on a brad and file it to a diamond shape, which will cut the hole. File off any burr, and trim the end round. Nip the corners from the other end. Bend as shown in the detail drawing. The bearing itself must not be exactly vertical, however. It slopes a little forward, thus making the propeller pull downward a trifle.

Cement the bearing to the top of the motor stick, bind it with fine thread, and cement the thread all over.

The tail is built next. For the base, cut a piece of $\frac{3}{32}$ by $\frac{5}{32}$" balsa 3¾" long. Put a pencil mark on it 3" from the forward end, and taper the under side of the motor stick at the trailing end so that when the tail is glued to the taper, the lower edge at the pencil mark will be even with

the lower edge of the motor stick. Cement it centering on the taper.

The leading spar of the tail is 5½″ long, and the trailing spar, 5⅜″. The latter is butted on the end of the base, and

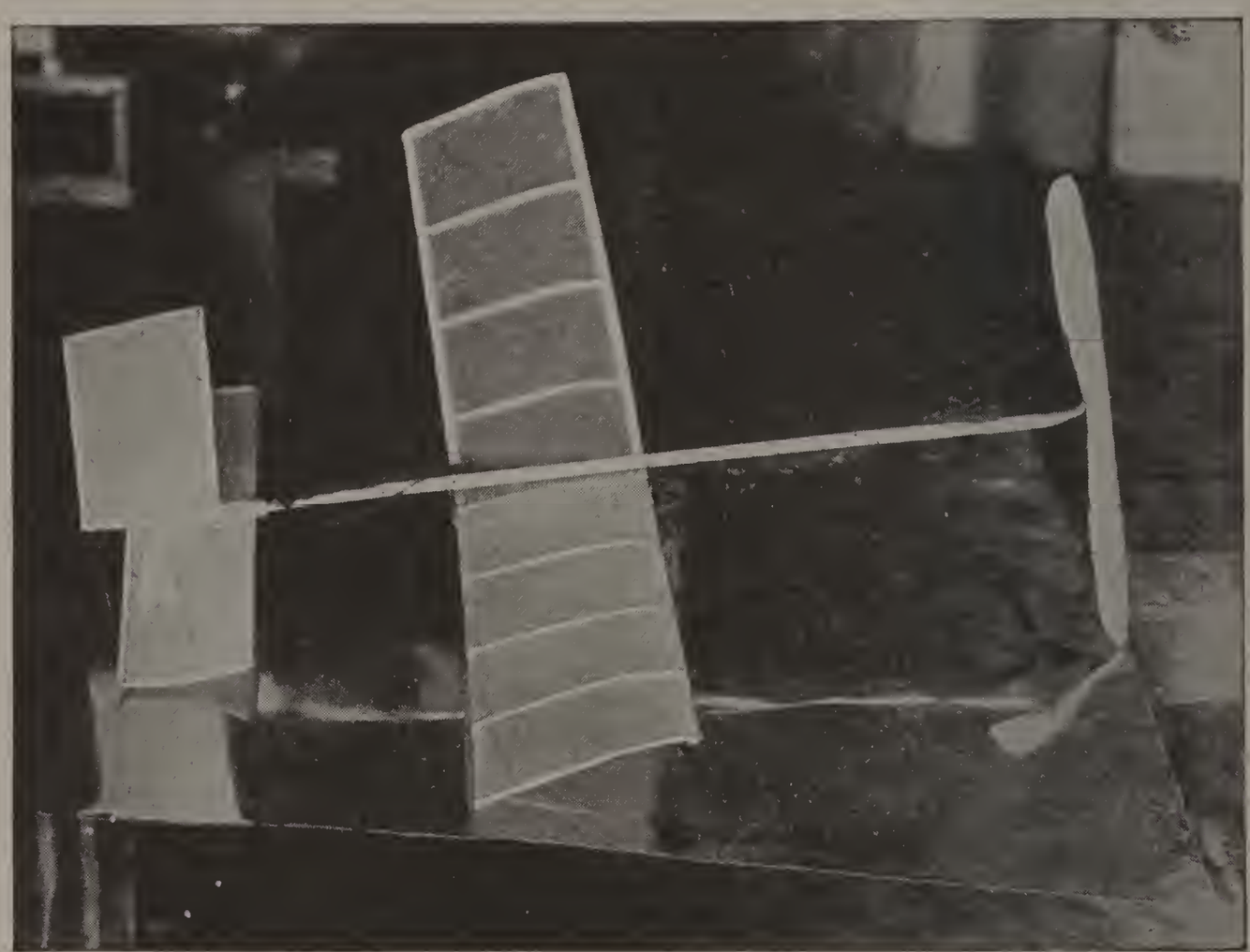


ENDURANCE STICK MODEL

the leading spar butts on top of the base and against the stick end. A straight rib between the upper ends completes the frame. Push a pin through the leading spar into the end of the motor stick, inclining it downward so the point will enter the base stick. Round the corners of the frame.

Cover one side with rice paper, dope it, and trim the edges when dry.

Cement the stabilizer, hollow side up, beneath the tail base stick, being certain that it is square with the stick and the tail. If it seems weak, brace it with a thread from the



rear corners to the upper trailing corners of the tail.

Carve the propeller from a balsa blank ¾ by 1⅛ by 12″. The diagonals do not run from corner to corner, as with a true-pitch propeller, but are drawn between points 3 in. from the ends. Round all corners when the carving is done, and sand the blades to $\frac{1}{16}$″ thickness.

Bend the hook in the propeller shaft, thrust the straight

end through the propeller hub, bend a hook and push it into the hub. Use three light brass washers or washers cut from celluloid.

Make the "S" winding hook, loop an eight-strand rubber motor with ⅛" slack between the hooks, and try the ship for gliding. To overcome stalling, move the wing back, and for nose dives, move it forward. When a smooth, flat glide is obtained, wind the propeller until half the first knots show, and try it. Adjust the bearing angle until it flies under power with good altitude gains with the wing at a perfect gliding angle, and you are ready to use the winder.

The plane, for ordinary flying, should be adjusted for circling, by warping the tail a little to one side or the other, since it will fly so far that it may not be recovered if allowed to go straight. Flown on a hillside, against a rising breeze, as a glider is flown, it might go out of sight.

7

A BRACED-WING MONOPLANE

This little plane, like Lindbergh's ship, *The Spirit of St. Louis* which he flew to France, is braced with a pair of struts attached to each side of the wing. Having no fuselage, a vertical strut is brought down from the center rib to carry the lower ends of the struts.

For this model these materials are needed: Motor stick, one piece of balsa $\frac{5}{32}$ by $\frac{7}{32}$ by 24″; for wings, two pieces $\frac{3}{32}$ by $\frac{5}{32}$ by 24″, and two pieces $\frac{3}{32}$ by ⅛ by 18″; one piece $\frac{1}{16}$ by ½ by 24″; for the propeller, one piece ⅝ by 1¼ by 10″; for prop shaft, "Y," and S-hook, 7″ of $\frac{3}{64}$″ music wire; for wing tips, skids, stirrups, etc., 16″ of $\frac{1}{64}$″ music wire; for prop bearing, one piece of aluminum $\frac{1}{16}$ by $\frac{5}{32}$ by ⅞″; three small washers; also fine thread, pins, rice paper 9 by 30″, ambroid cement, wing dope, and mucilage.

Draw the wing on a board. Round the corners of the $\frac{3}{32}$ by $\frac{5}{32}$″ balsa strips with sandpaper. Cut one 24″ long, and lay it on the drawing, holding it with pins. The trailing spar must be broken at the center and cemented again, so as to fit the angle. It is cut off at the ends even with the leading spar.

Make the center rib from a piece of $\frac{1}{16}$ by $\frac{1}{2}$" balsa. Notice that the curve is sharpest toward the leading end, with the highest point $\frac{7}{16}$" from the lower edge. Hollow the lower edge each way from the widest point, to lighten it, and notch it to fit the spars. Do not cement it in place, however, until the other ribs are in position.

The other ribs are cut about $\frac{1}{8}$" longer than the distance they span, using $\frac{1}{16}$ by $\frac{1}{8}$" balsa. Round the corners, then

roll the undersides with a lead pencil, giving them camber. Lighten the pressure one third the way back from the leading ends, and with a razor blade trim the ends flat to fit the spars, where they are cemented.

When the glue is dry, gently lift the frame a little and cement in the center rib.

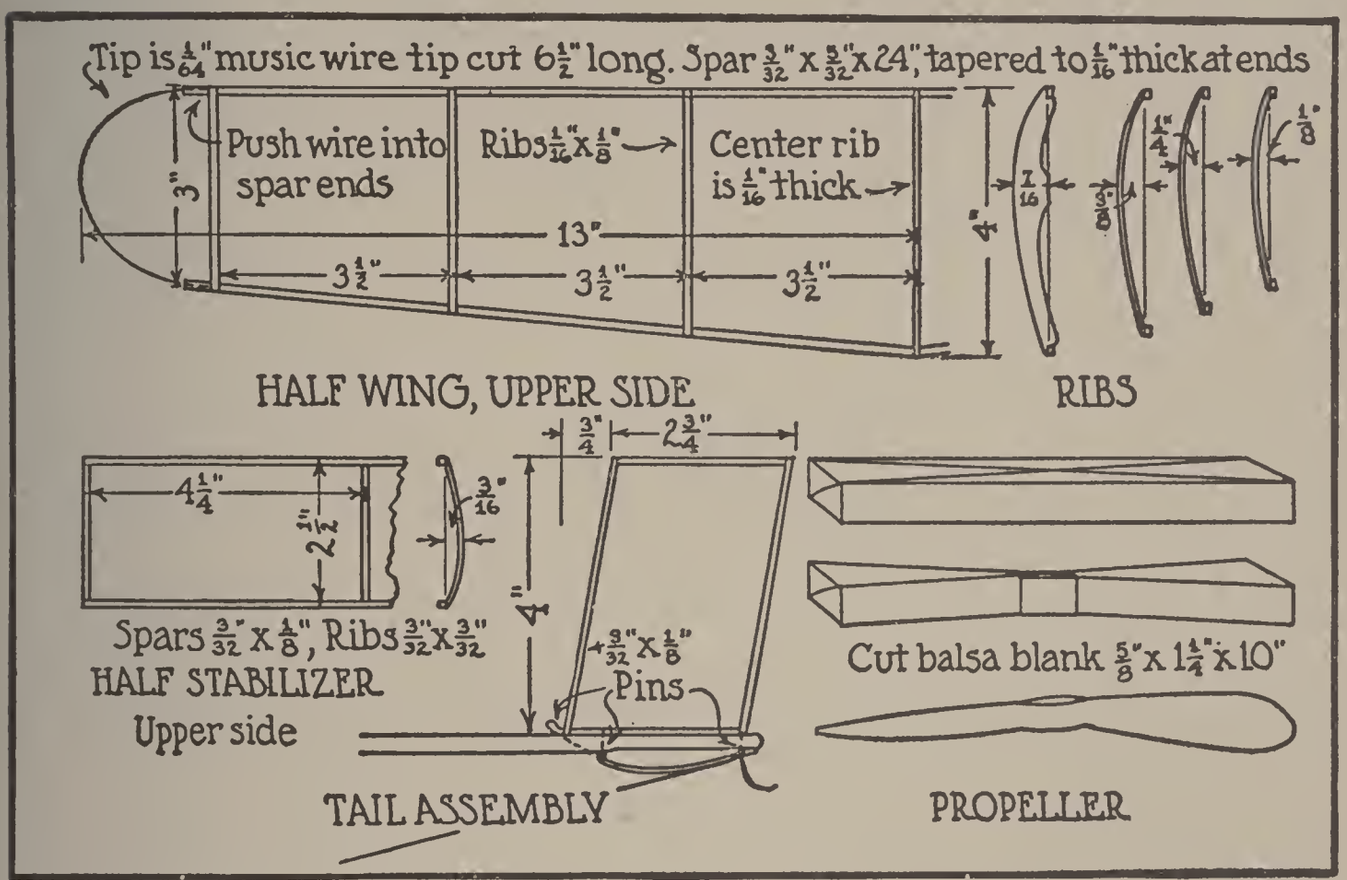
Cut 6½″ of $\frac{1}{64}$″ music wire for each tip. Bind the spar tips with thread, coat the wire ends with cement, and push them into the spar tips until the curved wire projects 2″, giving a total wing span of 26″.

Break the spars partly through at the centers. This is for the dihedral angle. Cement the breaks, and let them dry.

Glue a ⅛ by ⅛ by 3¾″ strut at right angles to the center rib, notching the upper end to fit at the side of the rib. Trim the corners round.

Cut the four struts $\frac{1}{16}$ by ¼ by 8½″, tapering them as shown. Cement two of them to the end of the center rib strut, with the other ends cemented under the leading spar. When dry, glue the ends of the other struts over the first and cement their other ends to the trailing spar of the wing. Use care, though, to see that the wing is true. Looking at it in front, with the spars of the wing to the left aligned, the leading spar of the wing to the right should rise a little higher than the trailing spar, giving that side lift to offset the propeller torque.

Cover the upper side of the wing with rice paper, one half the wing at a time, gluing it with mucilage to the outer edges of the spars, the center and the end ribs. Trim the paper with 1/8″ projecting outside the wire tips, and paste



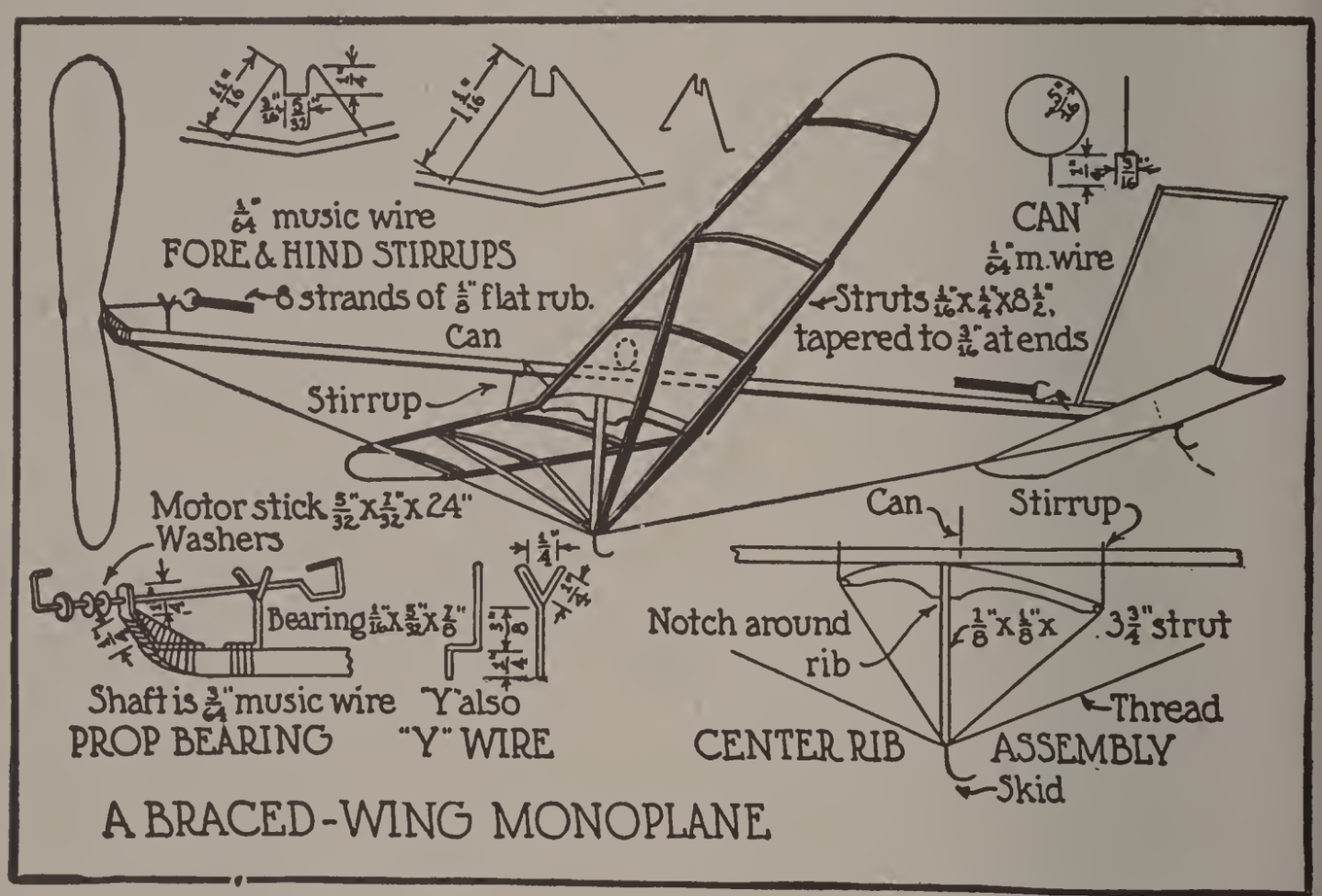
over the wire. Give the wing one coat of thin dope, running a little along the under side against the unglued ribs.

The stabilizer is made much the same, but with three ribs and no dihedral angle. Cover the ribbed side with rice paper, and dope.

The tail is 2¾ by 4″, a rectangle racked back at the top ¾″. Cover it on one side with paper.

The motor stick, with corners rounded, is curved at the fore end on the under side, and thinned at the tail end to 1/8 by $\frac{5}{32}$″, leaving the upper side straight.

Drill the bearing aluminum 1/8″ from one end, bend the metal back at about 40 degrees 1/8″ below the hole, and bend again 1/4″ farther on, another 45 degrees. Cement this part at the front of the stick, and above it cement a small brace-block of balsa. Bind with thread, and cement again.



A BRACED-WING MONOPLANE

The "Y" wire is a fork to hold the hook end of the propeller shaft higher than the bearing, so that the propeller will pull downward a little, keeping the plane from stalling. The lower end is thrust into the motor stick, with the offset cemented and bound to the stick.

Cement the tail to the top of the stick, as shown in the drawing. The stabilizer is cemented hollow side up, to the under side of the stick. Push a pin through the spars into

the stick and the tail, and a long pin diagonally through the stick, projecting above for a hook.

Carve the propeller with blades $\frac{1}{16}$" thick. Bend the shaft, cement it in the hub, and install the propeller with its bearing. Hook four, six, or eight strands of $\frac{1}{8}$" flat rubber to the shaft and S-hook.

Bend the stirrups, push the ends into the wing spars, and cement. Put the wing about halfway between the bearing and stabilizer, push a wire skid into the tail and the tips of the wing struts, and glide the plane until the position of the wing has been found. Run a guy-thread from the front end to the wing struts, wrapping it once around the skid, and bringing it back to the tail. Draw it tightly enough to bend the stick a trifle upward in the center.

To keep the stick from bending sidewise, make the wire circle, or "can," pushing the ends into the stick above the wire. Pass the rubbers through it.

If the plane stalls under full power, a higher "Y" wire is needed, so that the prop will pull downward more. If it flies in short dips, the "Y" is too high.

The ship flies well with four strands of rubber, circling at a height of about thirty feet; but for elevation, and a long glide at the end, more strands are necessary.

8

A TWIN-PUSHER PLANE

Many endurance records have been made by twin pusher planes. They are easy to put in fore-and-aft adjustment, and the "A"-frame, carrying two good motors, is light and very strong.

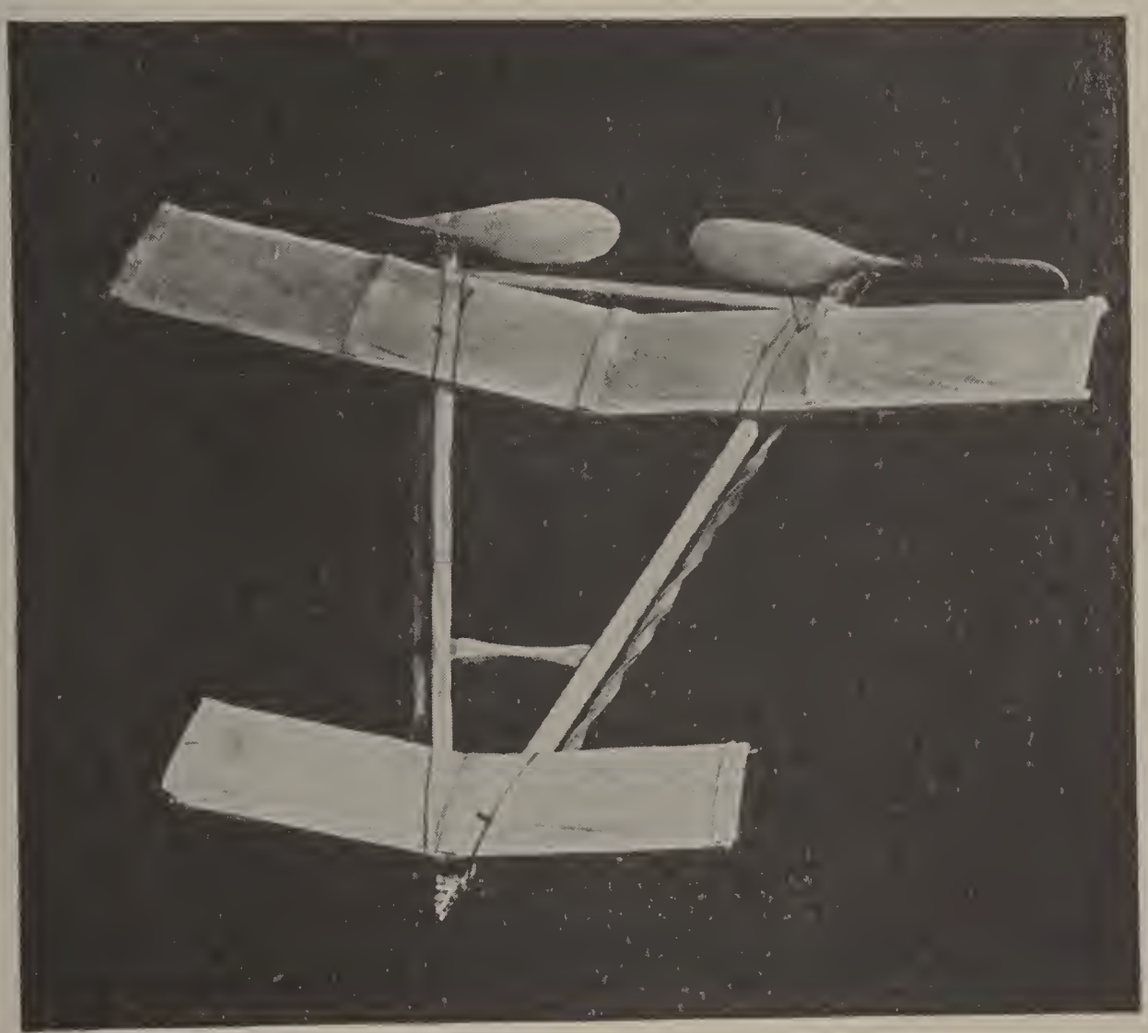
The little pusher model described here is too small to have a great deal of endurance, but it is inexpensive to build, and will give much sport.

For materials, get these: Balsa, two pieces $\frac{3}{16}$ by $\frac{3}{16}$ by 18″; one piece $\frac{1}{8}$ by 1 by 22″; two pieces $\frac{5}{8}$ by $\frac{7}{8}$ by 6″; bamboo, one piece $\frac{1}{16}$ by $\frac{1}{8}$ by 18″; aluminum, $\frac{1}{32}$ by $\frac{3}{16}$ by 2½″; music wire, 12″ of $\frac{1}{32}$″ diameter; also four celluloid washers, two glass beads, ambroid cement, dope, thread, two shingle nails, rice paper 6 by 16″, $\frac{1}{8}$″ flat rubber, 10 feet.

Cut the $\frac{3}{16}$″ square sticks 16″ long, sand smooth, and round the corners. Taper the front ends so that, when glued together, the other ends are held apart 5½″. The cross pieces are of $\frac{1}{8}$″ balsa, ½″ wide for the front, and $\frac{3}{8}$″ for the rear. Sand these pieces to $\frac{3}{32}$″ in thickness, sharpen the ends from the sides, and cut in the edges, as

shown in the drawing, to lighten them. Sand off the corners, press slits in the edges of the side pieces, and glue the pointed ends of the cross pieces into the slits. Glue the forward ends of the $\frac{3}{16}$″ pieces, and bind them with thread.

Cut a 2″ length of music wire, bend it at the middle to



fit the front end of the frame, and twist the ends back into hooks. Cement this double hook to the frame.

Make two aluminum bearings 1¼″ long, bending ½″ of each back almost at right angles. Drill a propeller shaft hole in the shorter part of each, and glue and bind them to the rear ends of the frame sides, projecting ¼″ to the rear and outward.

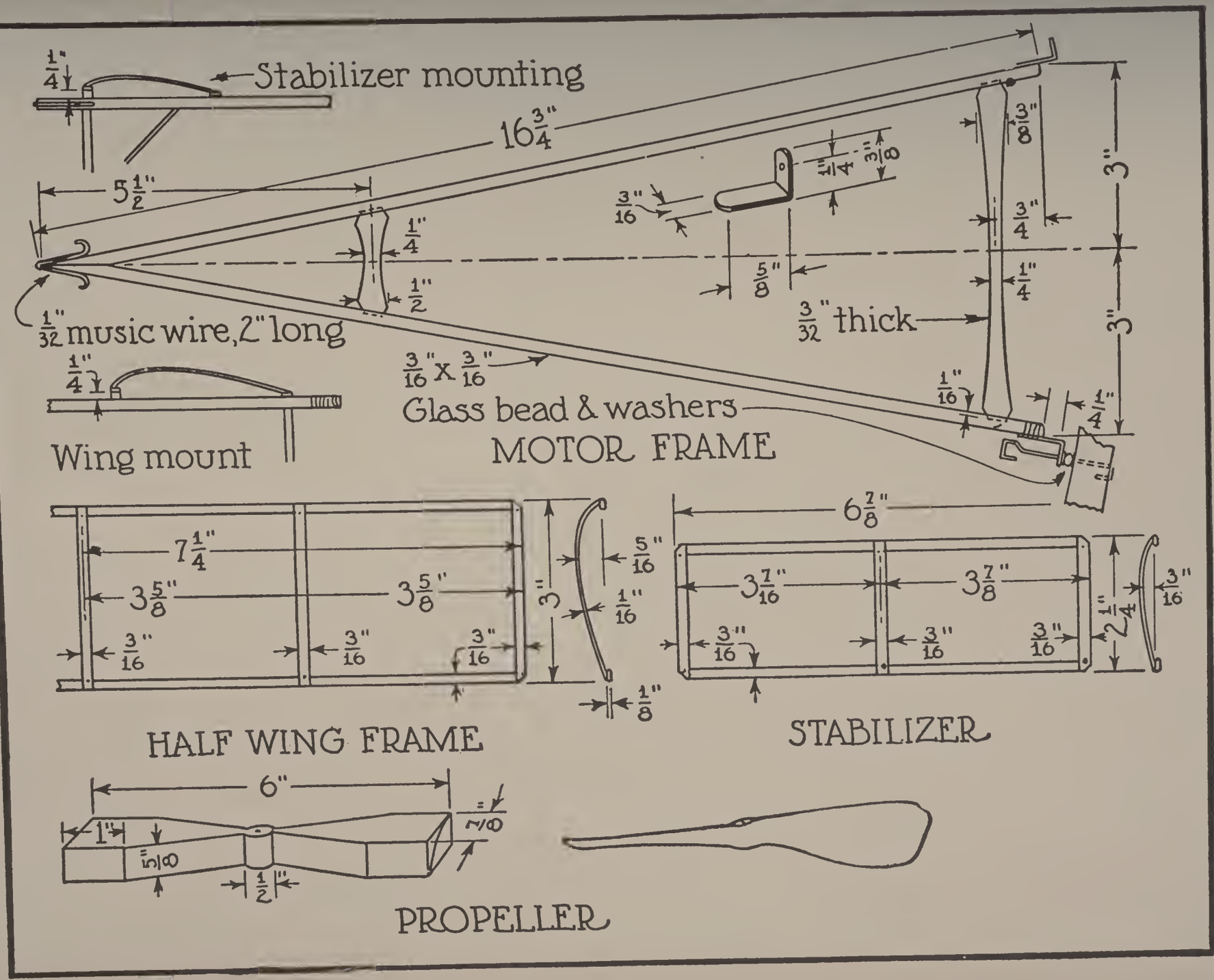
Lay out the propeller blanks with diagonals drawn from points 1″ from the ends. Be sure to carve them opposite, that is, one for turning right-handed, the other, left.

Cut the propeller shafts 3″ long, bend a motor hook on one end of each, and push the other into the hub of a propeller. Bend a hook on the projecting end to push into the hub for making it fast to the propeller. Cement it there.

The wing spars are 14½″ long. Make them $\frac{3}{16}$″ wide, sanding them smooth and rounding the corners. Also smooth five rib pieces ⅛ by $\frac{3}{16}$ by 3$\frac{3}{16}$″ long, and roll them with a pencil on the under side to give them camber, curving them more toward the front ends than at the rear ends. Miter the ends and glue them to the upper sides of the spars, a rib at each end, one in the middle, one in the center of each side. Break the wing spars at the center, raise the ends 1″, and glue the breaks. When dry, cover the upper side of each wing half with rice paper, gluing it to the ribs as well as to the spars. After trimming away the waste, any ragged threads can be quickly removed by rubbing fine sandpaper along the edges. Clip the wing corners with a razor blade.

The stabilizer spars are ⅛ by $\frac{3}{16}$ by 6⅞″. The three ribs are cambered in the same manner as those of the wing. The rolling compresses the thickness of the ribs to $\frac{1}{16}$″, as detailed in the drawing. Give the stabilizer a dihedral of ¾″.

Tie the wing to the top of the frame, just forward of


Stabilizer mounting
16 3/4"
5 1/2"
1/4"
1/2"
1/32" music wire, 2" long
Wing mount
3/16" X 3/16"
Glass bead & washers
MOTOR FRAME
3/32" thick
3"
3"
7 1/4"
3 5/8"
3 5/8"
3"
5/16"
1/16"
1/8"
HALF WING FRAME
6 7/8"
3 7/16"
3 7/8"
2 1/4"
3/16"
STABILIZER
6"
1"
PROPELLER

the propellers, and the stabilizer to the front end. Glue a ¼″ block under the forward edge of the stabilizer, thus giving it considerably more angle of incidence than has the wing. Because of this, a good lift is given to the nose of the plane, preventing nosedives, and yet, if it is blown upward to the stalling point for the ship, its high incidence angle will make it "burble" before the main wing does, so that it will fall and bring the plane level again.

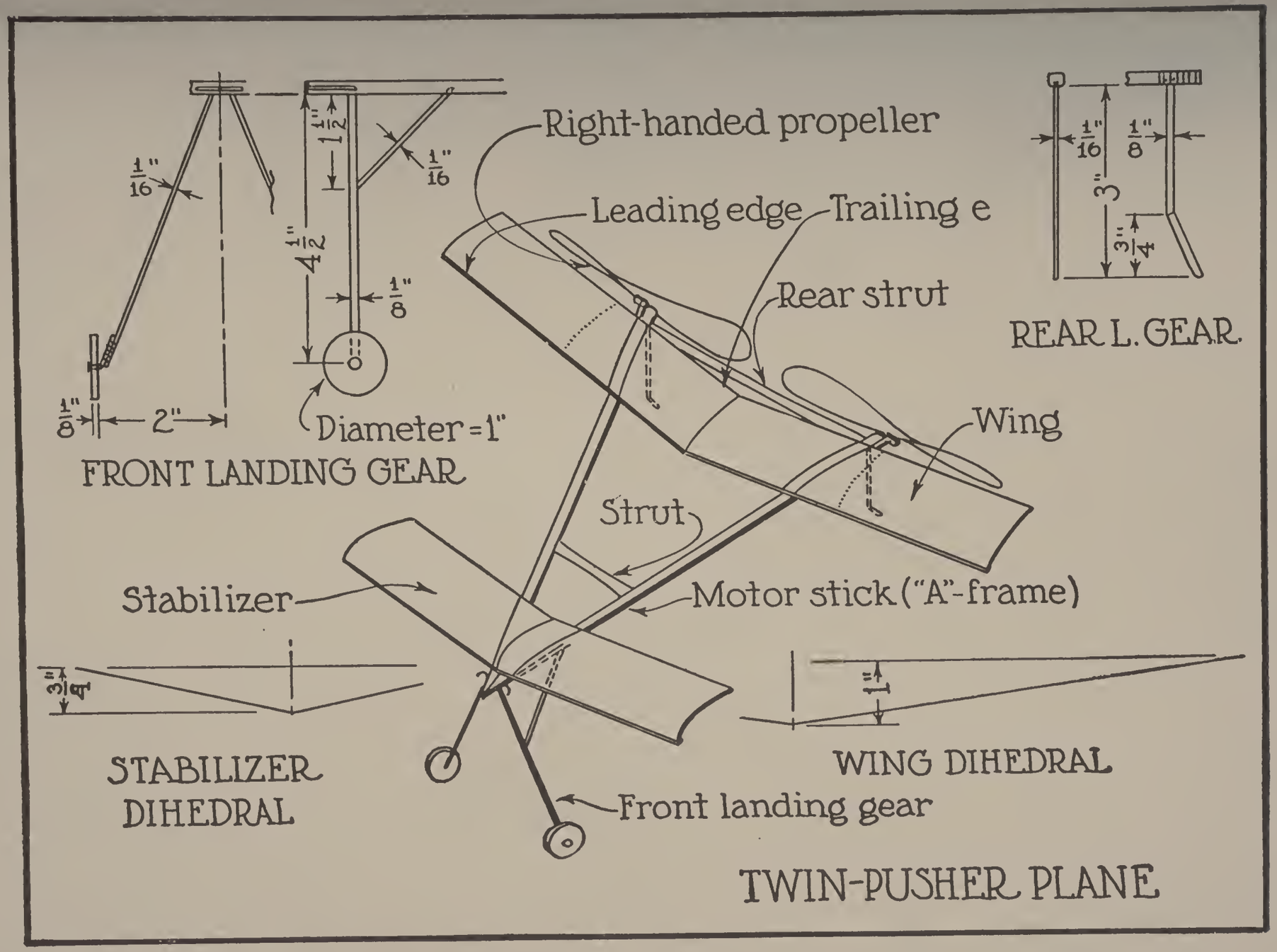
No rudder is needed for this model.

Install the propellers, bend an "S"-hook for each motor, and make a four-strand loop of ⅛″ flat rubber for each prop.

Glide the plane to find the proper position of the wing, before using any power, and then wind the motors only a little for test power flights. If these are satisfactory, wind up fully, and see it go.

While the pusher plane flies excellently without landing gear, it is evident that it is more likely to crack up upon descending to the ground if it has neither wheels nor skids. The drawings suggest a landing gear that is easy to add, although it is not very suitable for taking off from the ground.

Cut two pieces of $\frac{1}{16}$ by ⅛″ bamboo 4½″ long, point one end of each, and, coated with ambroid, thrust the points into the forward end of the frame. Incline them outward 1⅞″ at the bottom. Glue between the back edges and the undersides of the frame $\frac{1}{16}$″ square bamboo braces.


1/16"
1 1/2"
1/16"
4 1/2"
1/8"
1/8"
2"
Diameter = 1"
FRONT LANDING GEAR
Right-handed propeller
Leading edge
Trailing e
Rear strut
Wing
Strut
Motor stick ("A"-frame)
Stabilizer
Front landing gear
1/16"
1/8"
3"
3/4"
REAR L. GEAR.
3/4"
STABILIZER DIHEDRAL
1"
WING DIHEDRAL
TWIN-PUSHER PLANE

For spindles, bend shingle nails with the head sections horizontal when the points are bound to the sides of the bamboo struts.

Shape wheels from 1/8" flat balsa, push them over the spindles to the heads, and bind the nails to the struts. Smooth the binding with glue.

The rear landing gear consists of a prop or skid bound and glued to the rear of each frame side. Bend the tip of the skid backward, either by heating over a flame, or by breaking the bamboo and cementing it at the correct angle.

PART III

FUSELAGE MONOPLANES

1

A PUSH-PULL SCIENTIFIC MODEL MONOPLANE

For dependability and ruggedness of design the *Push-Pull* model is really splendid, and its unusual form in itself makes it worth while building. The dimensions given here are for an outdoor model, but an indoor model of this style could be made by greatly lightening the parts.

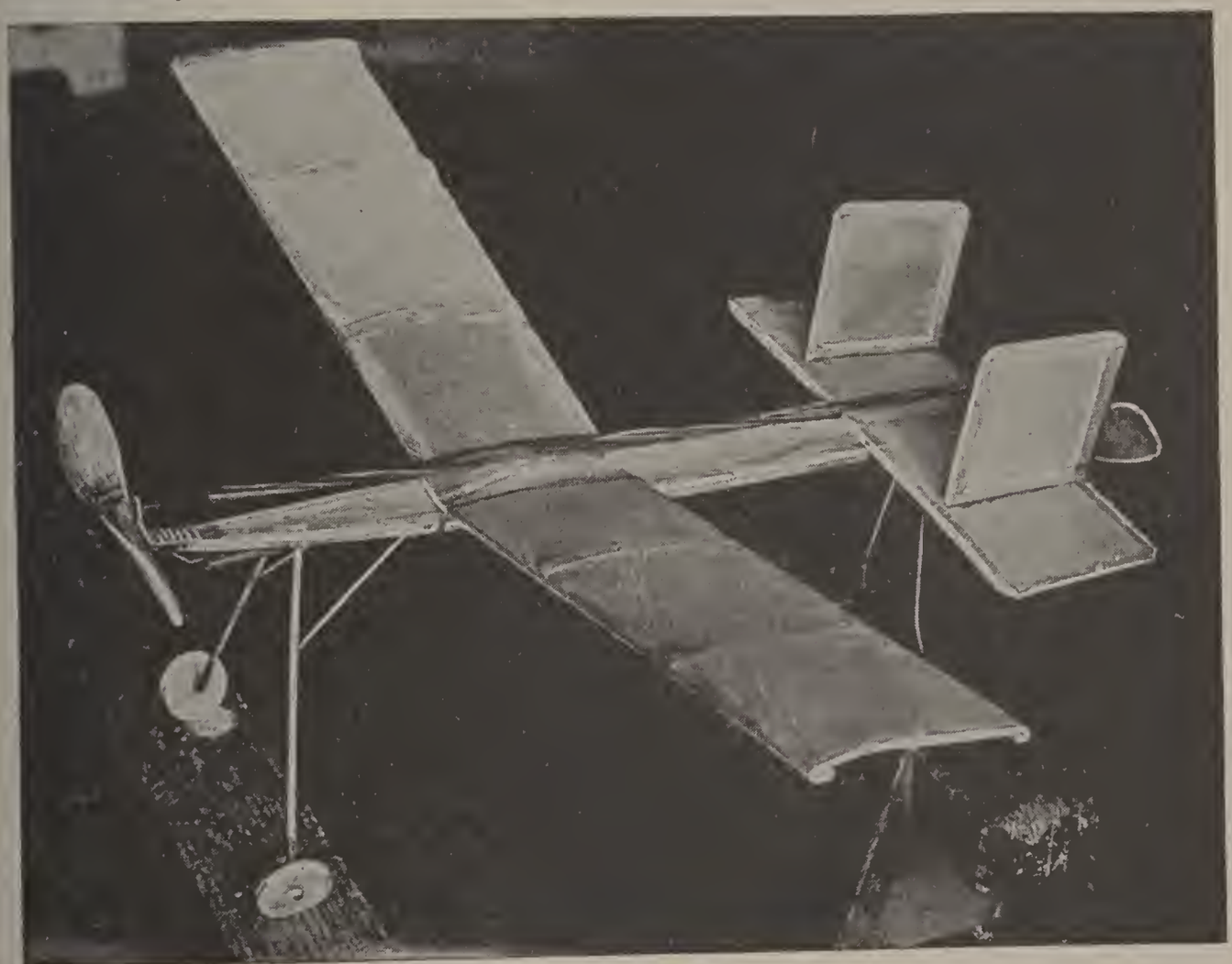
The motor frame consists of two longerons lashed at the ends, spread into fish-shape with four cross-struts, and covered on both sides with rice paper.

The following materials are required: Balsa, one piece 1/8 by 2 by 18″; for propellers, one piece 5/8 by 1 1/8 by 12″; landing gear, bamboo 1/16 by 1/8 by 24″; 1/32″ music wire 12″ long; sheet aluminum 1/32 by 1/4 by 2 3/4″; four small celluloid washers; two glass beads; rice paper 12 by 24″; 12 ft. of 1/8″ flat rubber; also ambroid cement, wing dope, and thread.

Cut the wing struts and pin them on a board, ready for assembling. Cut seven ribs, curving them by rolling the under sides lightly with a pencil, with the deepest curves about one-third the width back from the leading edges. Trim the rib ends to fit on the spars before cementing them in place on the tops of the spars. Cut the spars on the under sides, at the centers, so that a dihedral angle 2 1/2″ deep can be bent. Cement the joints, and when dry cover

the upper side of the wing frame with rice paper, half at a time, with a lapping joint at the center rib.

The stabilizer is flat, with two end ribs and two inner ribs which form bases for the tails. A double rudder is necessary because of the rubber motor above the body



frame. Cover the stabilizer on the upper side and cement it on the trailing end of the motor frame. The tails are alike, with slightly staggered frames covered on one side with tissue paper. Glue these upright on the stabilizer.

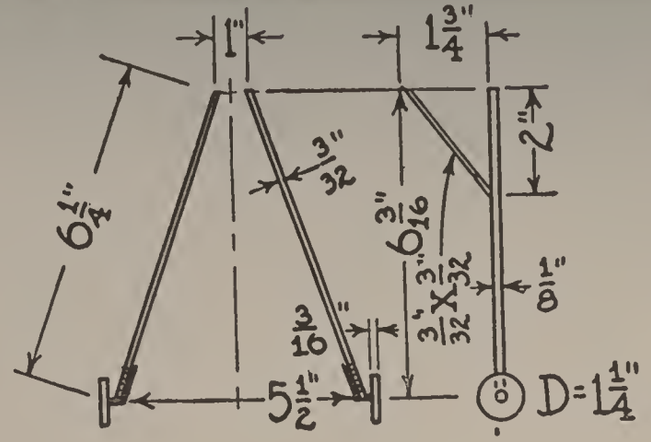
The front landing gear is constructed of two pieces of bamboo pointed at the upper ends and thrust into the under edges of the longerons about 1¼″ from the nose. Brace

these struts with similar bamboo strips cemented obliquely between the longerons and the struts. Use brads for wheel spindles. Cut the heads off and bend the ends over so that when the shanks are bound and cemented to the ends of the struts the spindles will be horizontal. Slip small celluloid wheels, or wheels cut from balsa, over the spindles, and hold there with cement on the tips of the spindles.

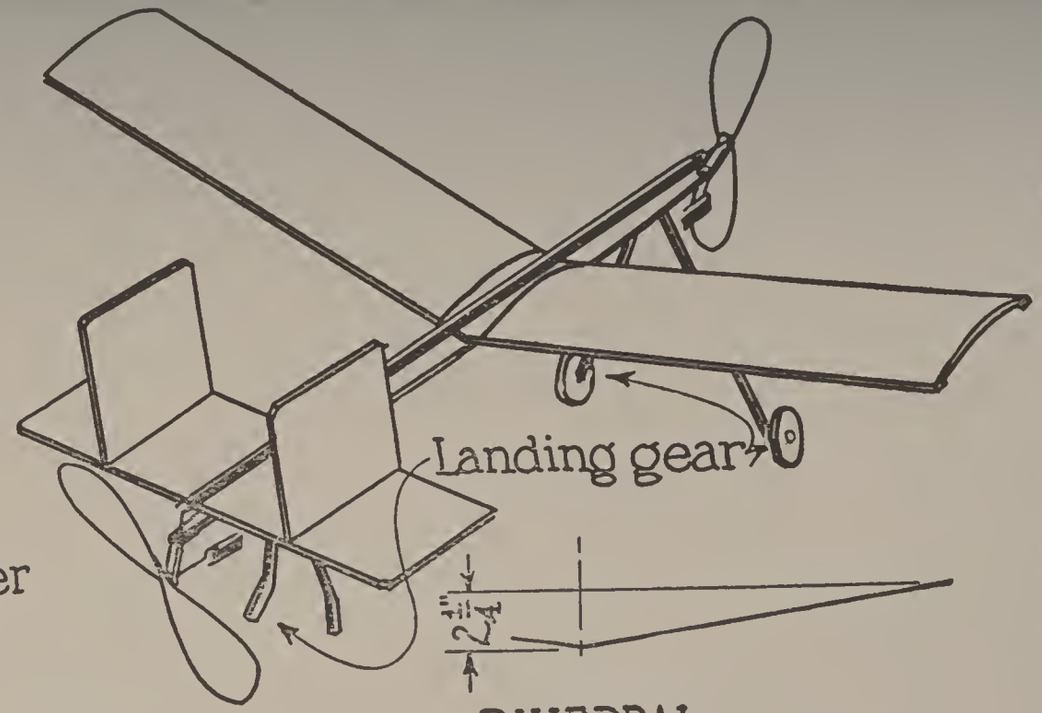
The tail landing gear consists of two bamboo struts shorter than those in front, cemented to the longerons. The lower ends are bent backward ¼″ by cracking them and applying glue to hold them.

The bearings are strips of aluminum, one cemented and lashed to the nose on top, the other underneath the tail. A tail hook of wire must be tied and cemented on top of the tail end, and a similar one underneath the nose.

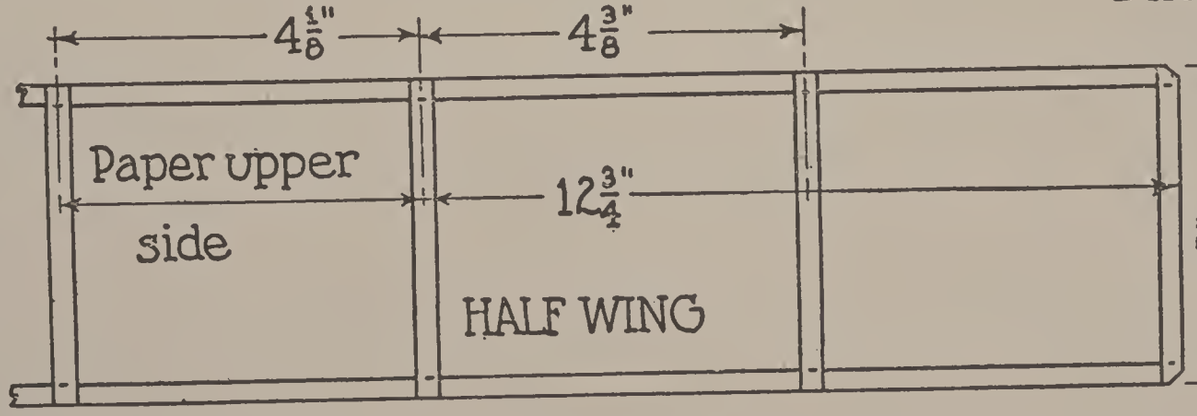
Carve two propellers from ½ by 1⅛ by 6″ balsa, being sure that one is left-handed and the other right-handed, so that both motors can be wound at once with a double winder. A glass bead between two celluloid washers forms a thrust bearing for each prop shaft. The wing is attached above the motor frame by means of rubber bands. Each motor requires four strands of ⅛″ flat rubber. Make two "S" hooks, both used at the tail. Thus, the rubber hooks directly on the front prop shaft, with an "S"-hook between it and the tail hook, while for the lower motor the "S"-hook is between the rear prop shaft and the rubber.

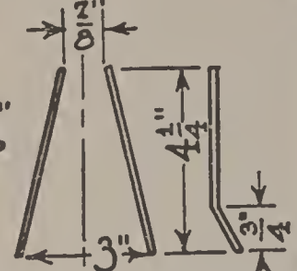


FRONT LANDING GEAR
Bamboo struts. Sharpen upper ends, cement, & push into the under edges of longerons



DIHEDRAL





REAR LANDING GEAR

PUSH-PULL SCIENTIFIC MODEL MONOPLANE

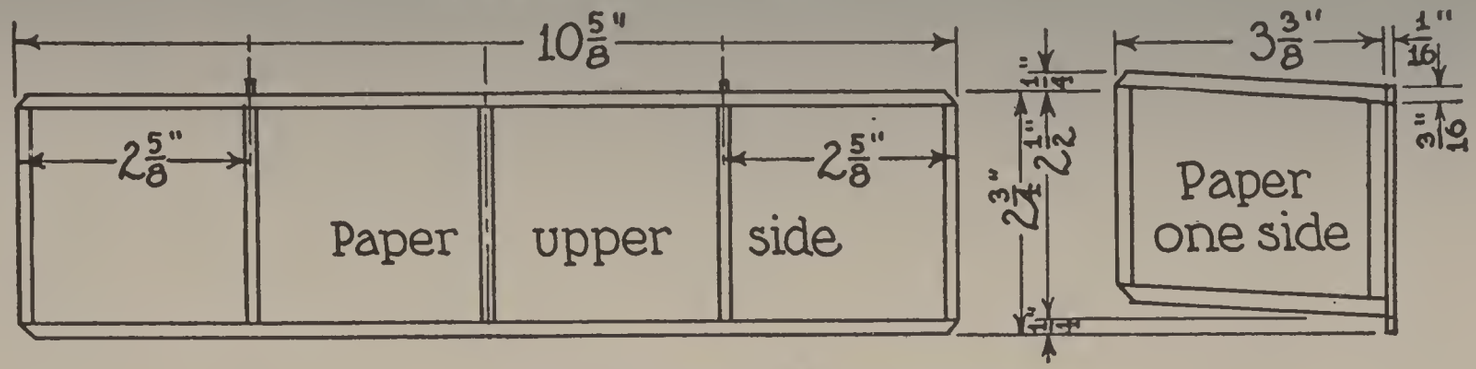
Varnish the wing and tail assembly cover with thin dope. When dry, place the wing, looping ⅛″ rubber under the body, over both sides of the wing, and under the body again.

Adjust the wing forward or backward to a good gliding position, and the plane is ready for a power flight. Attach the "S"-hooks to a double winder and stretch the motors to a little more than twice their length. Wind about half, and give a short test flight. If the plane fails to gain altitude, cement a ¼″ balsa block under the leading edge of the wing to give an increased angle of incidence, and consequently more lift. It is useless to increase the angle more than this, however, as the lift is decreased and the drag is greatly increased. A little lifting of the trailing edge of the stabilizer may also help.

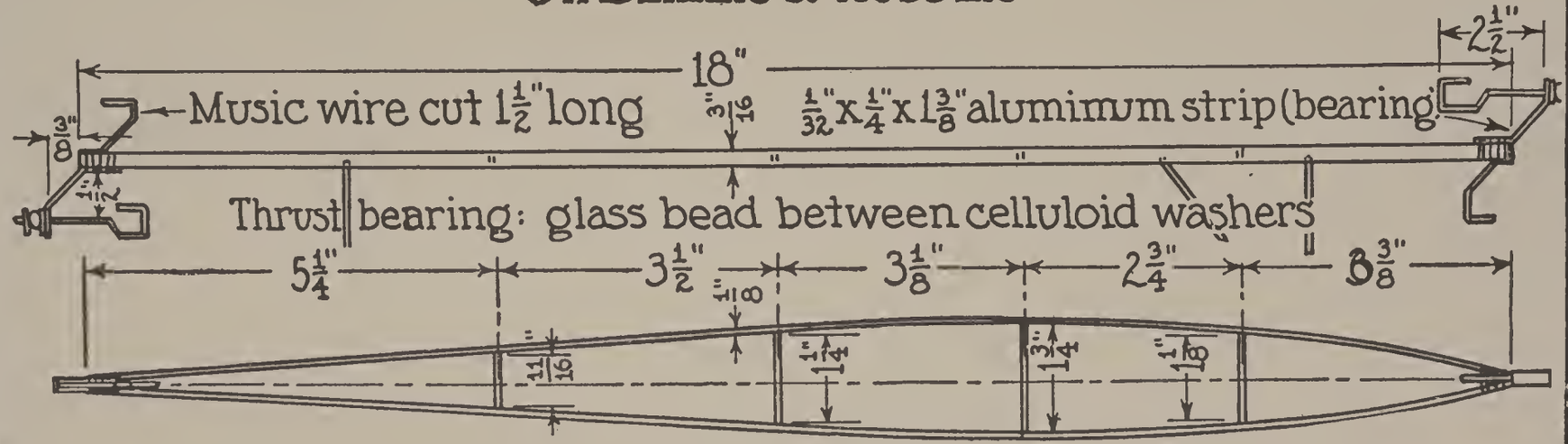
It is almost impossible to stall this plane, so no downward pull on the front propeller is necessary.

Since this is such a fool-proof plane, it will last some time without a crackup if reasonable care is given it. This being the case, it is a good idea to "treat" the motors to reduce wear and to help prevent rotting. If the strands are shaken up with talcum powder they will slide on one another when in use, thus reducing friction and heat. Some boys moisten them with glycerine. Graphite, too, is good, but it is so dirty to handle that it is not to be recommended.

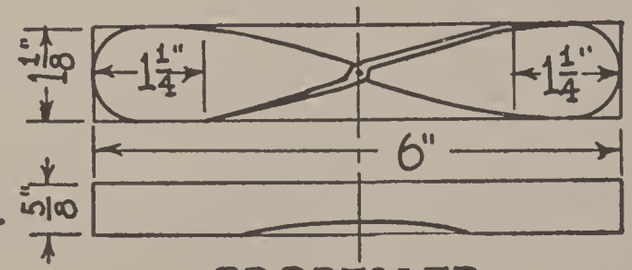
When the rubbers are not in use, take them off the plane and lay them away in a fruit jar in a cool, dark place.



STABLIZER & RUDDER



MOTOR FRAME
Paper both sides



PROPELLER

Attach wing to motor frame with rubber.
Glue stabilizer to upper side.

2

THE TEENY WEENY MONOPLANE

The *Teeny Weeny Monoplane* is a dainty little plane that is good for all kinds of flying thrills, for it loops, banks, zooms, and otherwise cuts capers in the air. Of course with careful adjustment, it can be made to soar in a very sedate manner, and with a fair amount of duration.

Materials needed are: Balsa, one piece $\frac{1}{16}$ by 1½ by 20″; ⅛ by 1 by 18″; $\frac{1}{32}$″ music wire 18″ long; rice paper 10 by 14″; two ¾″ celluloid landing wheels; two celluloid washers and a glass bead; ambroid cement, wing dope, thread, fine wire. The propeller blank is ¾ by 1 by 6″, and four strands of ⅛″ rubber, or about 4 ft. are needed for the motor and for attaching the wing.

Cut the wing spars and seven ribs. As the width of the finished wing is 2½″, the ribs must be about 2⅝″. Sand smooth, and roll the ribs for camber. Miter the ends for gluing to the upper sides of the spars, and when assembling the wing remember that the most curved parts of the ribs go forward. The leading spar is shorter than the trailing.

When the frame is dry, break the spars at the center and cement them with the tips raised 1½″.

Cover the upper side of the wing, one half at a time, giving an upward twist to the front of the left side to offset the tendency of the motor to turn the plane over in an opposite direction to the motion of the propeller. Cement under the leading spar center a ⅛ by ⅛ by 1½″ balsa block.

The top and bottom of the fuselage are made in one piece each. Draw on paper a rectangle 1½ by 10″, dividing it into ½″ squares, and through these draw half the outline as shown in the drawing. Fold down the center and cut out, thus making one side exactly the reverse of the other. Trace this pattern on the $\frac{1}{16}$″ balsa, and cut out.

The shaped top and bottom are joined together with ⅛″ square posts. Draw them together with twine wrapped around the assembled fuselage until the glue dries. The tail post, it will be noticed, is reenforced with a 2″ length of music wire cemented and bound to the back edge, the part projecting below being bent back into a tail skid.

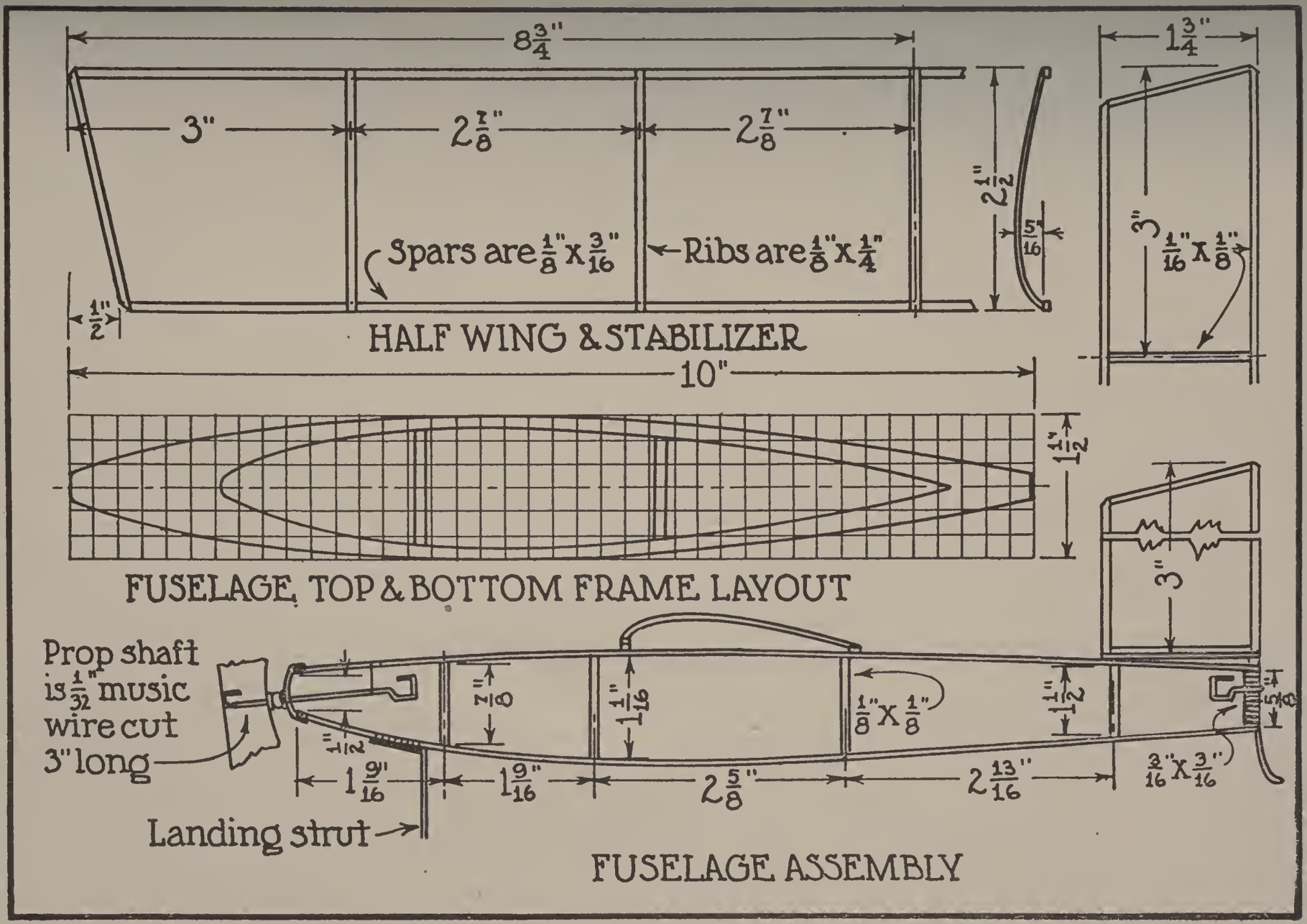
Cover all over with rice paper, and then cut an opening in the nose, back to the front post, and a like opening in the rear (left side only) for inserting the motor.

The stabilizer is flat, having ribs butted between the spars. Like the wing, the ends are not square. The shorter spar is in front. Glue this to the top of the fuselage, with a $\frac{1}{16}$″ balsa block under the trailing edge.

The tail fin is like a half-stabilizer. Cover it on one side and glue upright on the center rib of the stabilizer.

In making the landing gear, cut a piece of music wire 9¾″ long. Four inches from each end bend the legs downward, leaving a flat, or horizontal section, 1¾″ long. Bend this section sidewise ¼″ inside the first bends, and bend back again ½″ inside these, so that a horizontal "U" to fit against the under side of the fuselage is formed. Cement and bind with thread to the fuselage. Bend the lower ends of the struts horizontally for wheel spindles, slip on the wheels, and hold them in place with a ball of cement on the end of each spindle.

To attach the wing, loop a rubber band under the


8 3/4"
3"
2 1/8"
2 7/8"
2 1/2"
5/16
Spars are 1/8" x 3/16"
Ribs are 1/8" x 1/4"
1/2"
1 3/4"
3"
1/16" X 1/8"
HALF WING & STABILIZER
10"
1 1/2"
3"
FUSELAGE, TOP & BOTTOM FRAME LAYOUT
Prop shaft is 1/32" music wire cut 3" long
1/2"
1 9/16"
1 9/16"
2 5/8"
2 13/16"
1/8" X 1/8"
1 1/16"
1 1/2"
3/16" X 3/16"
Landing strut
FUSELAGE ASSEMBLY

fuselage, stretch the ends above, and slip the wing through these loops.

To lay out the propeller, smooth the blank, draw cross lines 1¼″ from the ends on the faces, and draw diagonals. On the edges draw lines tapering the thickness off one third at the ends. Pare down to these lines, and saw out the center-width pieces. Be sure to leave about ¼″ thickness for the hub.

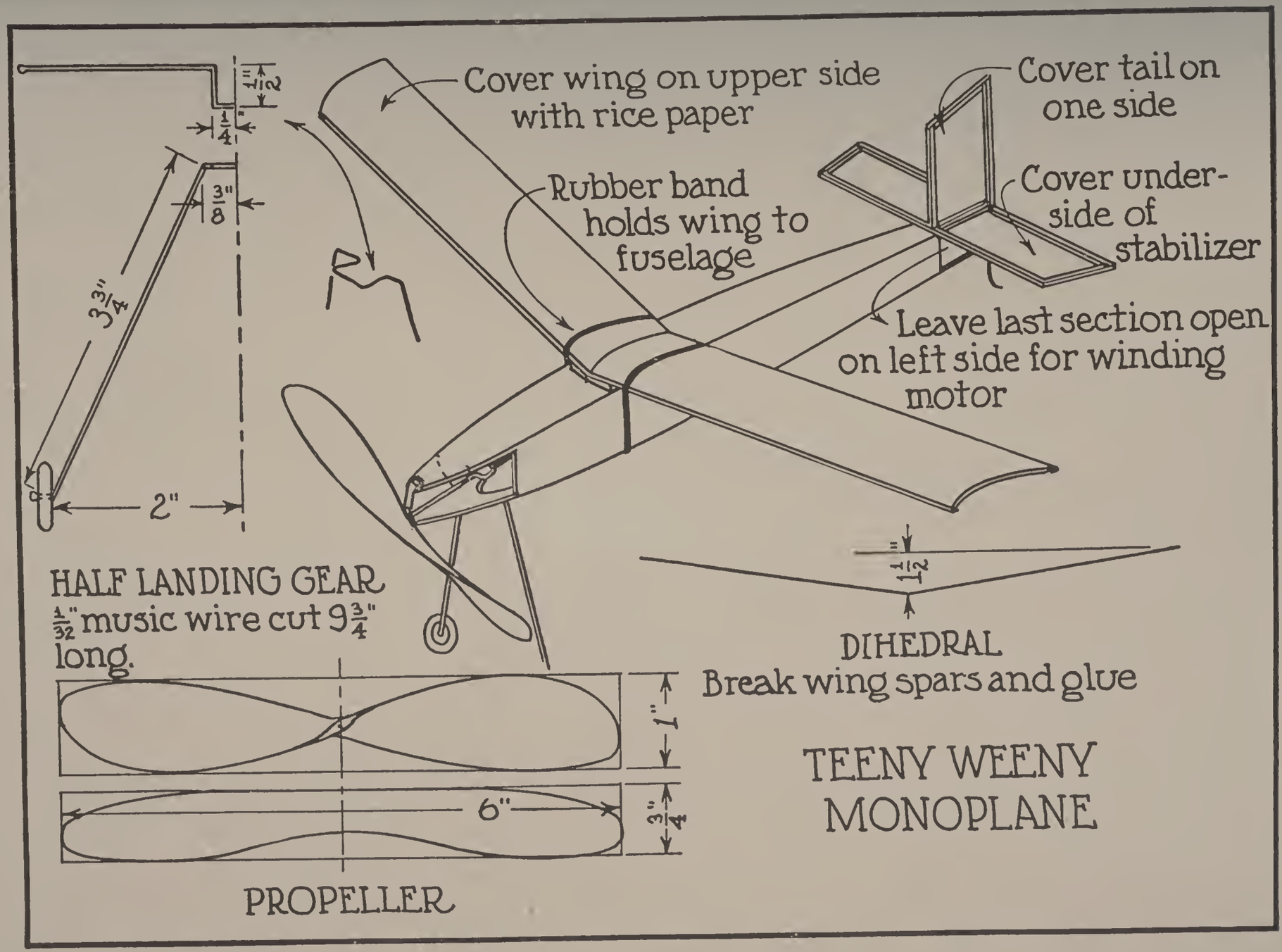
Whittle the inner faces of the blades, hollowing them about $\frac{1}{16}$″ in the width. They also curve backwards lengthwise because of the tapering back of the front, and this spoon shape must be carefully followed. When the backs of the blades are finished, do the fronts, making the thickness $\frac{1}{16}$″. Round the ends, hollow the back to about one-third the thickness of the blank, and complete the blades.

Push the propeller shaft through the hub, bend a hook, and force this into the front of the hub, where it is cemented. Bend the motor hook, and install the shaft in a bearing made of heavy tin, brass, or aluminum, which is cemented and bound to the nose of the fuselage.

Make an "S"-hook to clasp the tail post.

To install the motor, tie a nail to a piece of string and drop it through the fuselage from nose to tail. Tie the string to the rubber loop, and pull it through. Loop it over the hooks.

Glide the plane to find the wing position. When this


Cover wing on upper side with rice paper
Cover tail on one side
Rubber band holds wing to fuselage
Cover under-side of stabilizer
Leave last section open on left side for winding motor
1/4
3/8
3 3/4"
2"
1/2
HALF LANDING GEAR
1/32" music wire cut 9 3/4" long.
DIHEDRAL
Break wing spars and glue
1"
6"
3/4"
PROPELLER
TEENY WEENY MONOPLANE

has been located, try a flight with the motor partly wound up. So high-powered is the little machine that it will go up in a half-loop and fly upside down for some distance. As this maneuver is dangerous for the plane, the propeller must be pointed downward a little by looping a fine wire around the upper side of the fuselage and under the shaft, so as to raise the hook. With proper adjustment, and hand launching, the plane will sweep down almost to the ground, and then, as the power of the motor decreases and the downward pull of the propeller lessens, it will gain altitude and circle around.

3

A FUSELAGE LOW-WING MONOPLANE

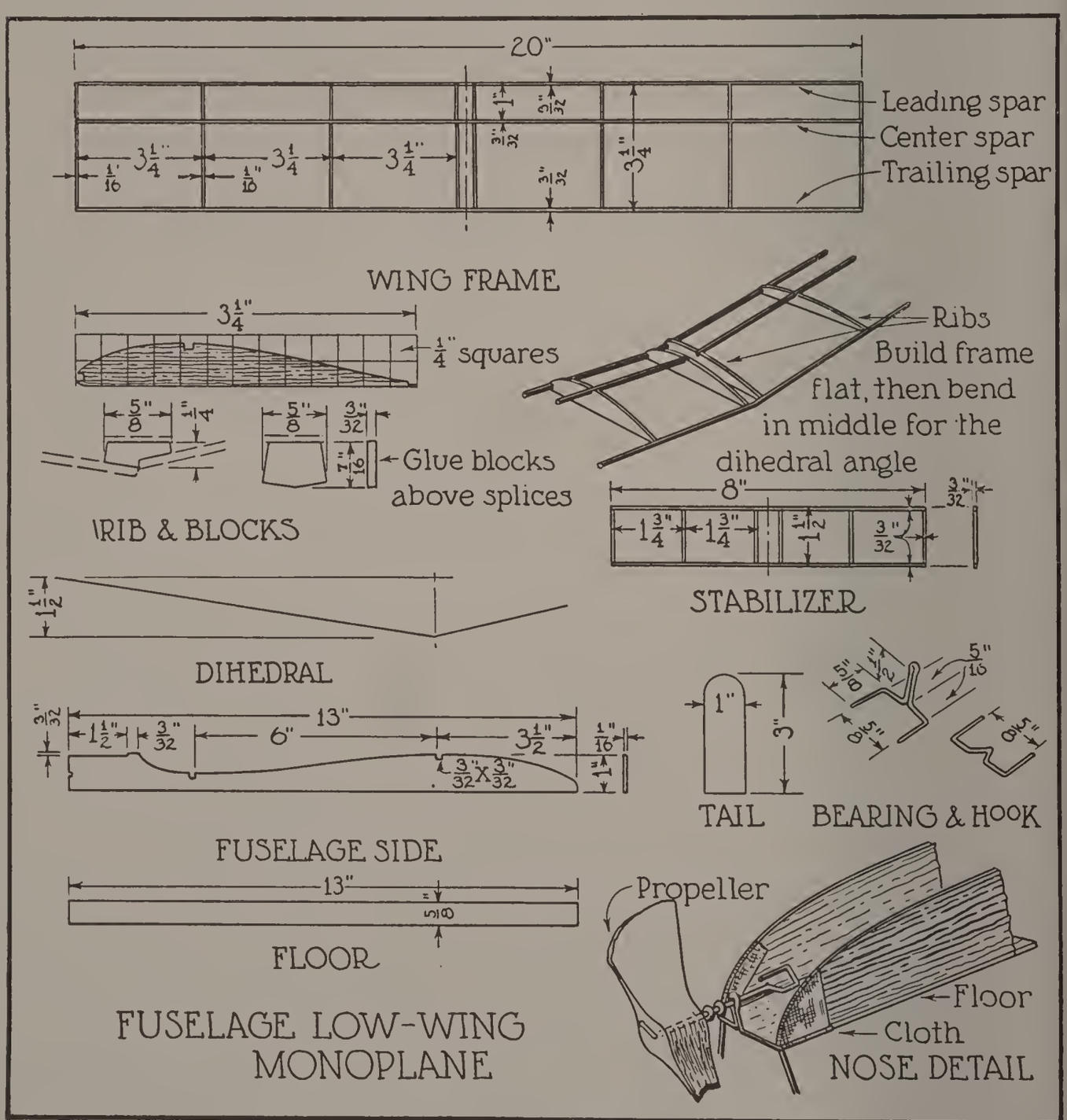
A flying model plane that climbs well is likely to be a poor glider, and the good glider may not gain much elevation. For a long flight, a distance glide is needed, since the rubber motor can keep the propeller pulling for only a short time. If the motor while working can get the plane high in the air, and the ship can glide in a satisfactory way, it may take considerable time to reach the ground, and if it should fly over a warm spot where the air is rising, it might actually gain elevation after the propeller has stopped turning.

In this plane the stabilizer is placed some little distance above the level of the wing.

For wing spars, get three pieces of $\frac{3}{32}$ by $\frac{3}{32}$ by 20″ balsa; for the stabilizer, one piece 30″ long; for ribs, fuselage sides, tail, etc., one piece $\frac{1}{16}$ by 2½ by 24″; for propeller, one piece ¾ by 1¼ by 10″; for propeller shaft, hooks, etc., three hairpins; for landing gear, 16″ of music wire the size of mechanical pencil leads; for wing covering, Japanese rice paper, or other tissue, 8 by 24″; for the motor, 5 ft. of ⅛″ flat rubber; also two glass beads, a rubber band, 1½″ of

rubber tubing for the hooks, ambroid cement, wing dope, and bits of light cloth.

Draw the outline of the wing on a board. Make the rib pattern of cardboard by drawing the ¼″ squares through which to sketch the outline. Trace the ribs and cut them out with a razor blade. The eight ribs, held side by side, can be notched at the same time. Glue in the front and



trailing spars, and then the upper spar. When dry, cut the front spar in the middle, score the trailing spar for breaking it, and cut the middle spar off flush inside the center ribs.

Cover both halves of the wing with the tissues. Coat the under side of the trailing spar with cement and glue one edge of the paper to it. Then bring the tissue around the leading edge and back, gluing it to the ribs and the upper side of the trailing spar. Trim the edges with a razor blade, and dope the wing.

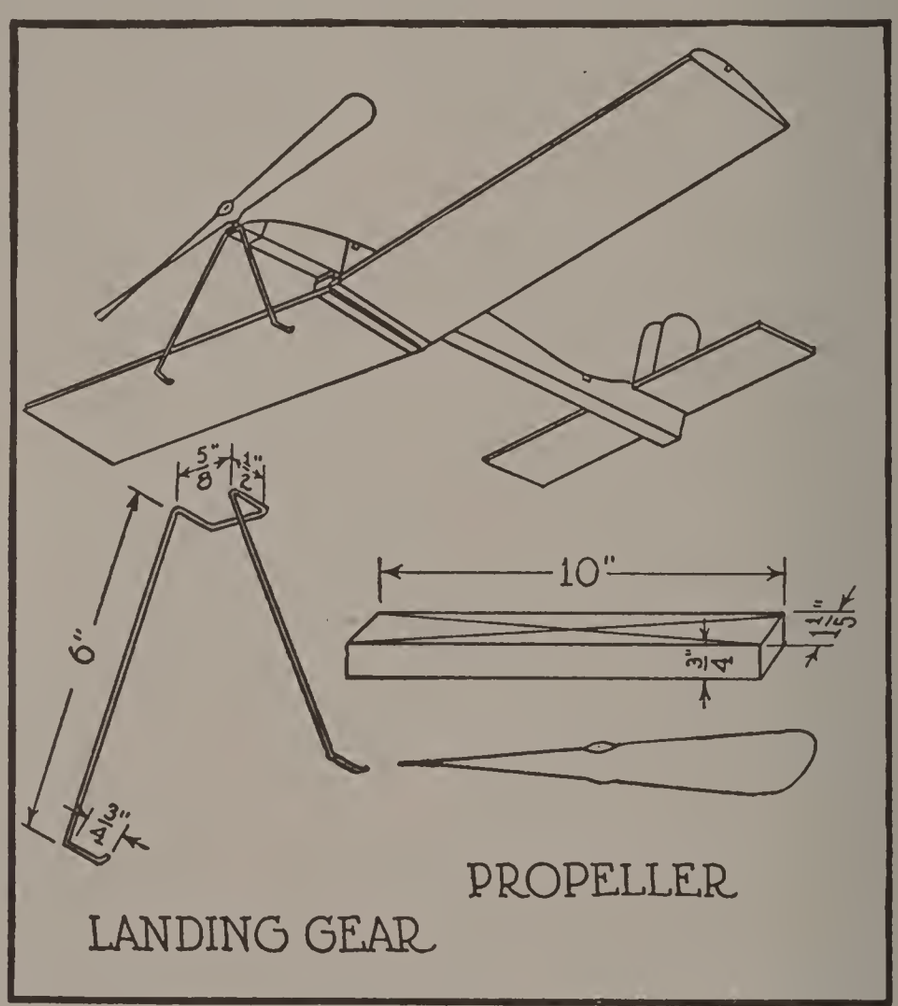
The two halves of the wing are joined with two splice blocks 1/8" thick. The trailing block comes to a blunt point at the bottom, and the lower edge of the front block slopes the same way, but is notched at the side to join the left wing, so that this side will have a greater incidence angle than the other, to overcome the tendency of the motor to revolve the plane in the opposite direction from the propeller. The ends of the plane are 1½" higher than the center, forming the dihedral angle. Glue a floor to the tops of the splice blocks, 1/16 by 5/8 by 3¼".

Cut the two fuselage sides from 1/16" balsa, notching them 1/32 by 1/32" at the top of the curve, and at the bottom, for struts. Notch the sides at the top for the stabilizer. Glue a 1/16 by 5/8 by 13" floor to the lower edges of the sides. Add the two cross struts, and the fuselage is complete.

The bearing is made from a hairpin. Bend the end around a brad, squeezing the wire together with pliers, and

½″ from the hole bend the wires apart. Bend them parallel again $\frac{5}{16}$″ farther on, and bend the bearing end up at right angles. Cement the wire inside the nose of the fuselage, holding it down in the corners until dry, and reenforce with $\frac{1}{32}$″ square blocks glued above.

For the landing gear, bend the music wire into a "U"

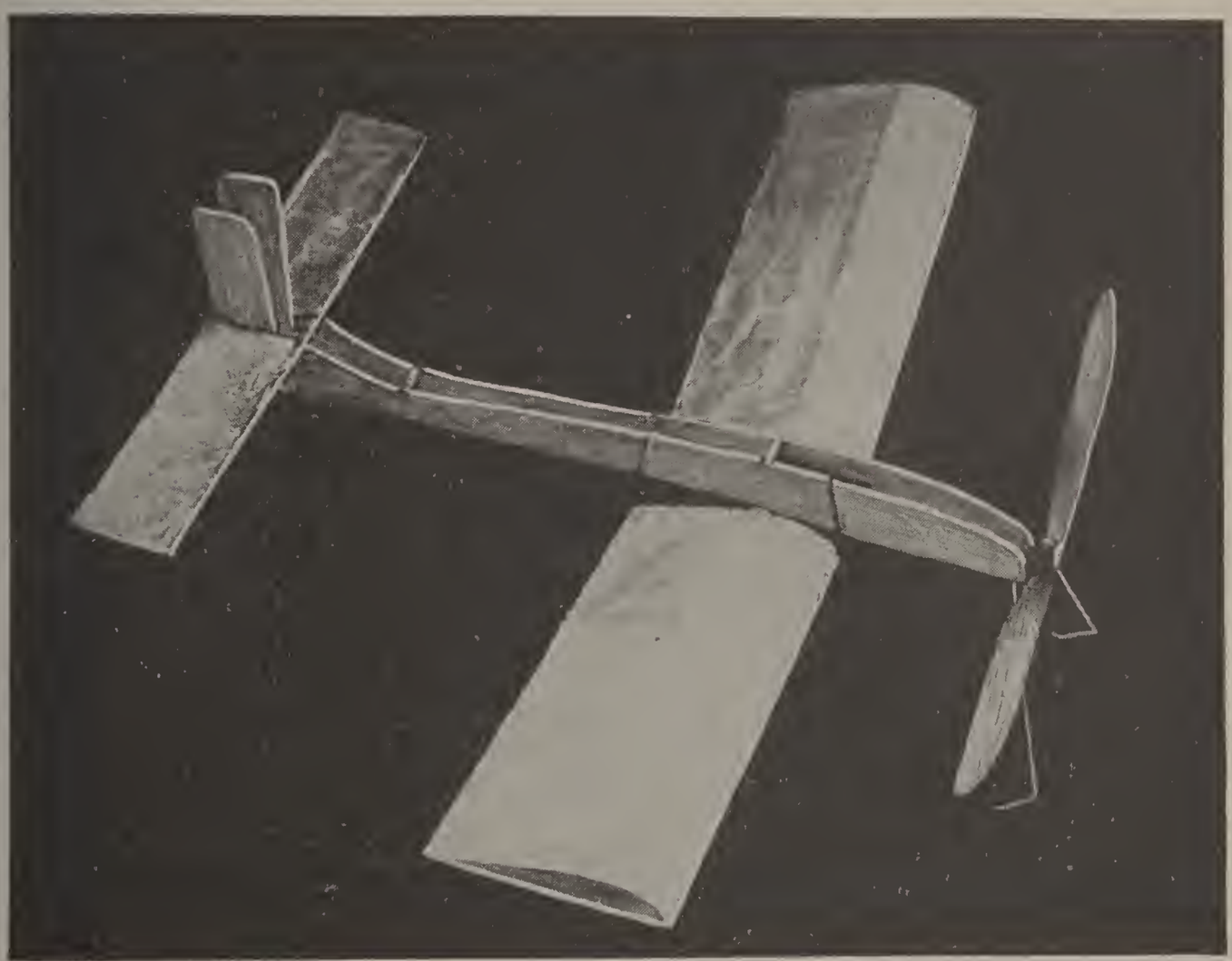


with a square bottom about ⅝″ wide. Bend this loop at right angles to the legs, ½″ down, and bend the legs out until at a point 5¼″ from the bend they are 5″ apart. Bend them back for skids, turning them up a little at the ends, and cut to a length of ¾″. Cement to the under side of the fuselage nose, and glue a strip of cloth over the loop, up

the sides of the fuselage, and with the corners folded over the upper edges of the sides.

The rear hook is also made of a hairpin, and the two legs are cemented outside the tail end of the fuselage.

The stabilizer is built over a pattern on a board, as was



the wing; but unlike the wing, it is flat, with ribs $\frac{3}{32}''$ square. It is covered on the upper surface with tissue, which is cut out in the center, so that the stabilizer can be glued in its notches in the fuselage.

The tails are $\frac{1}{16}$ by 1 by 3″, with the upper corners rounded a little and the edges sanded sharp. These are

then glued inside the fuselage, sloping backward a little.

To carve the propeller, draw diagonals on the faces of the blank and whittle the insides of the blades, hollowing them somewhat. Carve the outsides of the blades, sand them until light can be seen through them, and force hairpin wire into the hub. Bend the wire end at right angles, and cement.

The shaft hook should be 2½″ behind the bearing. Make an "S"-hook for the rear end of the motor, so that a winder can be used. Slip rubber tubing over both hooks.

Use two double strands of ⅛″ rubber for the motor.

Glide the plane until it balances well, and then try it out under power. If the rubber is stretched out to double-length with the winder before twisting, about twice as many turns can be given it without breaking.

4

THE SEAGULL TRACTOR

This little monoplane, with its tips sweeping back like the wings of a soaring seagull, is a splendid performer. The writer's model, with its rubber motor twisted by turning the propeller, and launched from the hand, rose some sixty feet in the air, made five or six large circles, and came down about 350 feet from where it started. If a winder had been used, the plane probably would have stayed aloft twice as long.

The wing spread is 20″, the fuselage length is 15″, and its weight, complete with the motor, is ¼ oz.

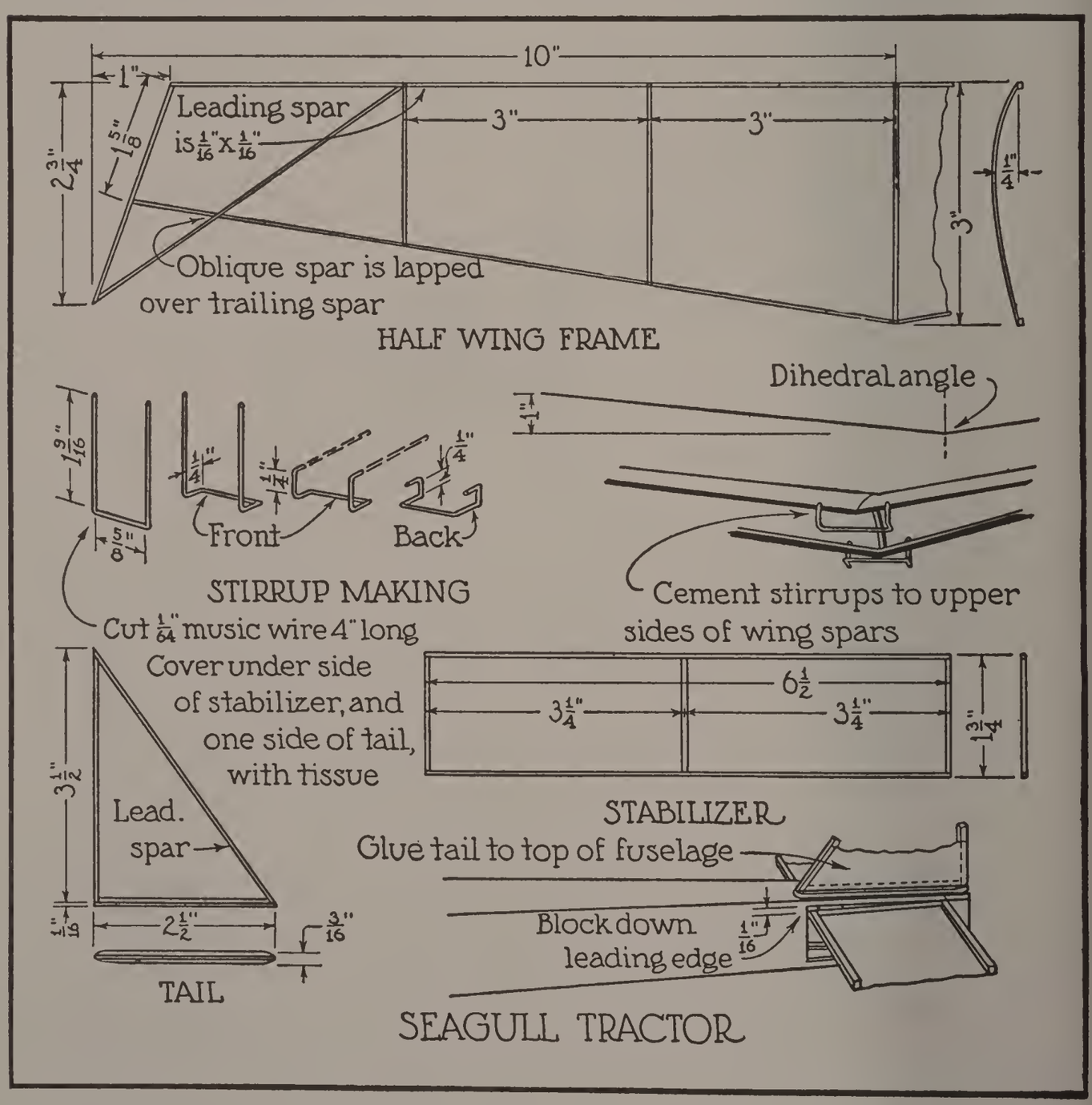
For materials, have a strip of $\frac{1}{16}$″ balsa 1 by 24″; for landing gear, etc., 40″ of $\frac{1}{64}$″ music wire; also wing dope, ambroid cement, mucilage, fine thread, 8 ft. of ⅛″ flat rubber, a small bit of camera film or other thin celluloid, and rice paper 8 by 20″.

The first step in building the plane is to lay out the pattern of the fuselage plan on a board or table top. Draw a center line 15″ long, and at the tail make marks $\frac{1}{16}$″ each way from the center. A foot from there locate marks ½″ each side of the center. Draw lines connecting, which rep-

resent the outsides of the longerons, and draw cross lines every 2″ for the struts.

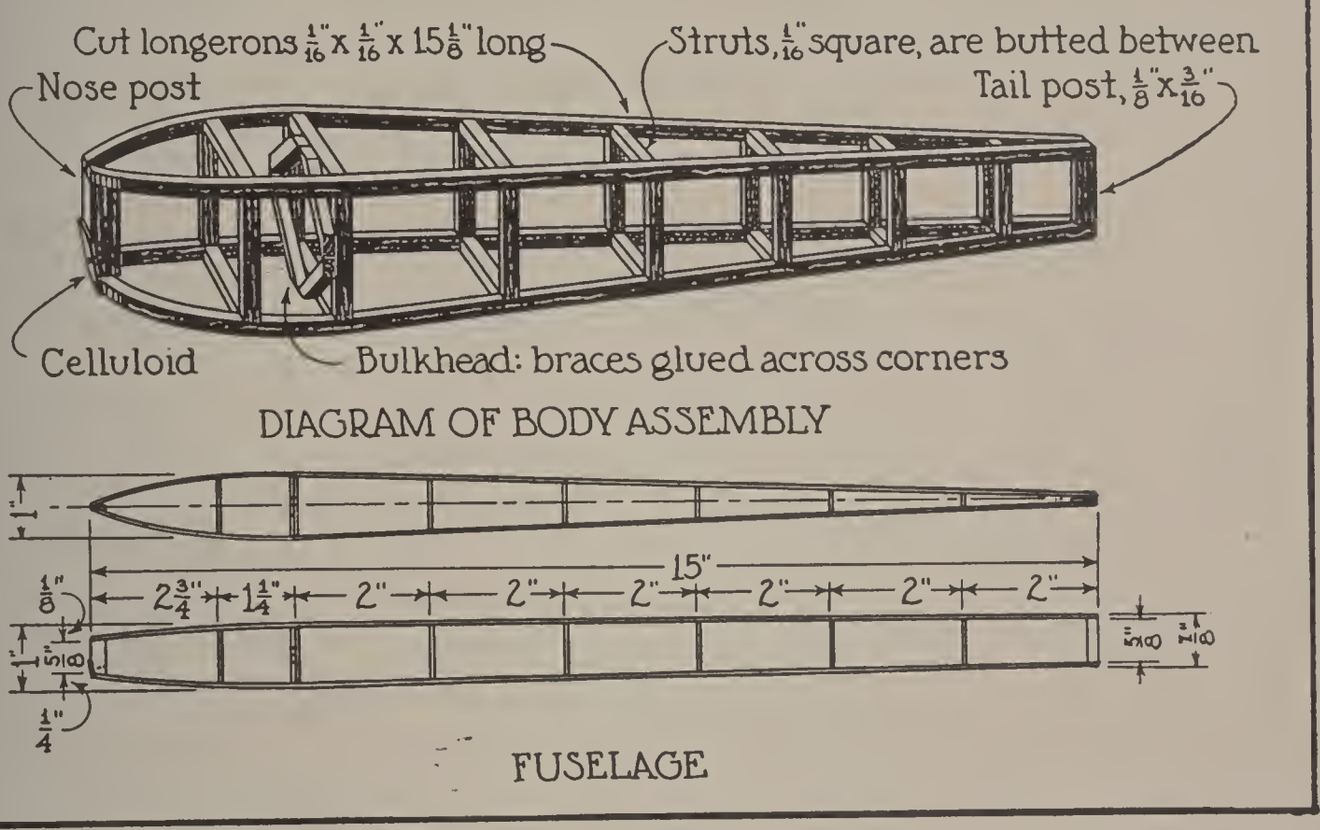
Push several pins in to hold the longerons in place, but for the time do not do anything with the curved nose.

Now lay a ruler on the veneer, and with a razor blade cut four strips $\frac{1}{16}$″ wide for longerons. Trim them to 15⅛″ in length. Ambroid one end of a pair, and lay the pieces inside the pins on the plan. Cut from the scraps $\frac{1}{16}$ by



$\frac{1}{16}$" struts to fit snugly between the longerons, and ambroid them in place. When dry, cement the nose and pin the longeron ends together. Fit in the remaining strut.

The upper fuselage frame is built on top of the lower, with a sheet of waxed paper between to keep them from sticking together. When taking the frames apart, spring

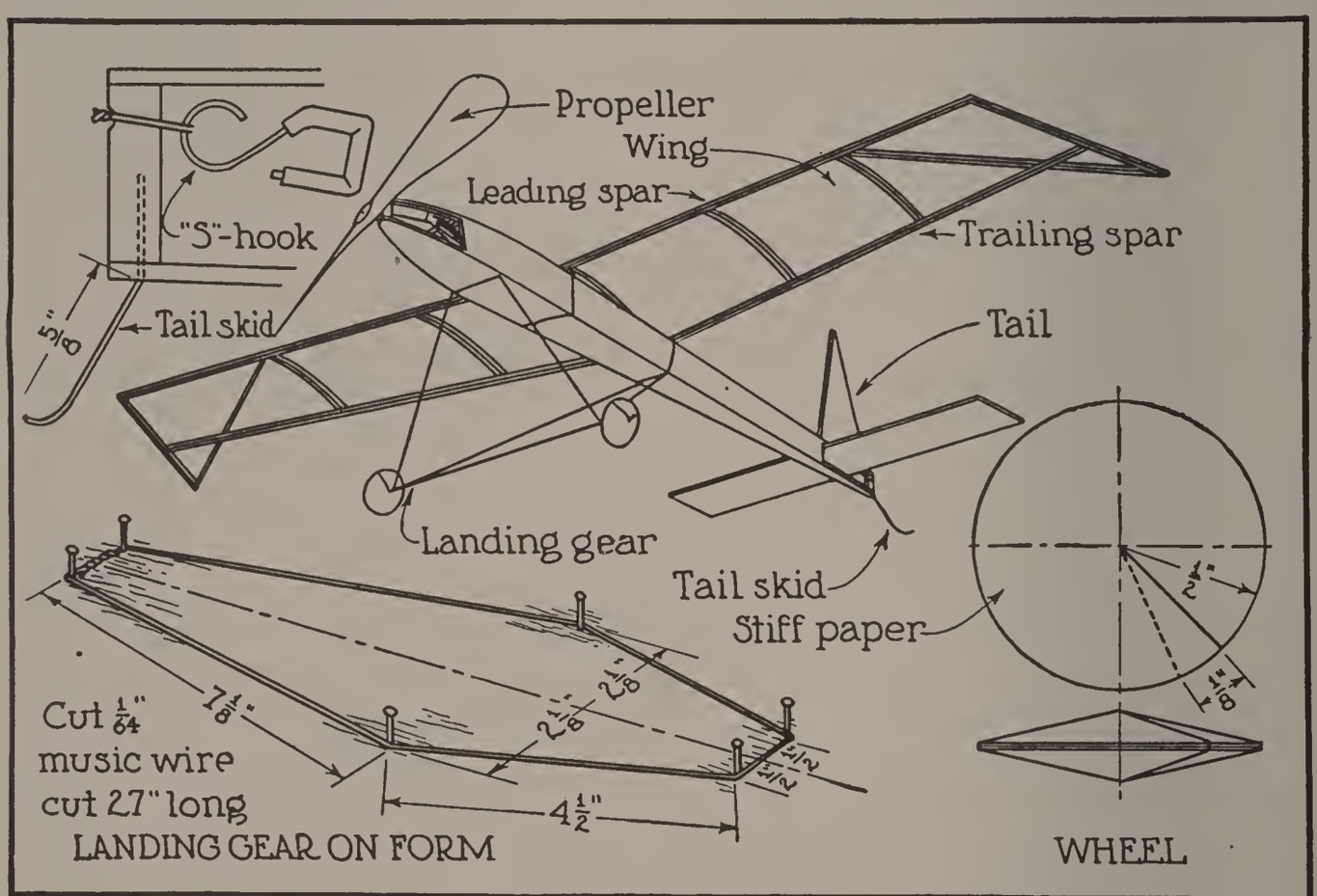


the pins outward, slip a thin knife blade between the frames, while raising up the free ends with the fingers, and gently pry apart any stuck places. In the same way loosen the lower frame from the board, but press it down flat again.

Lay a 7/8" block on the lower frame, 11$\frac{15}{16}$" from the tail end. Tack nails at each end to keep it from shifting, and pin the upper frame on top, directly above the lower. Cement the tail post in, and add the struts. Be sure that

the tail post and struts are vertical. When dry, remove the blocking.

Glue $\frac{1}{16}$" square balsa pieces across the corners of the bulkhead, which will brace the assembly and prevent the frames from racking to one side or the other.

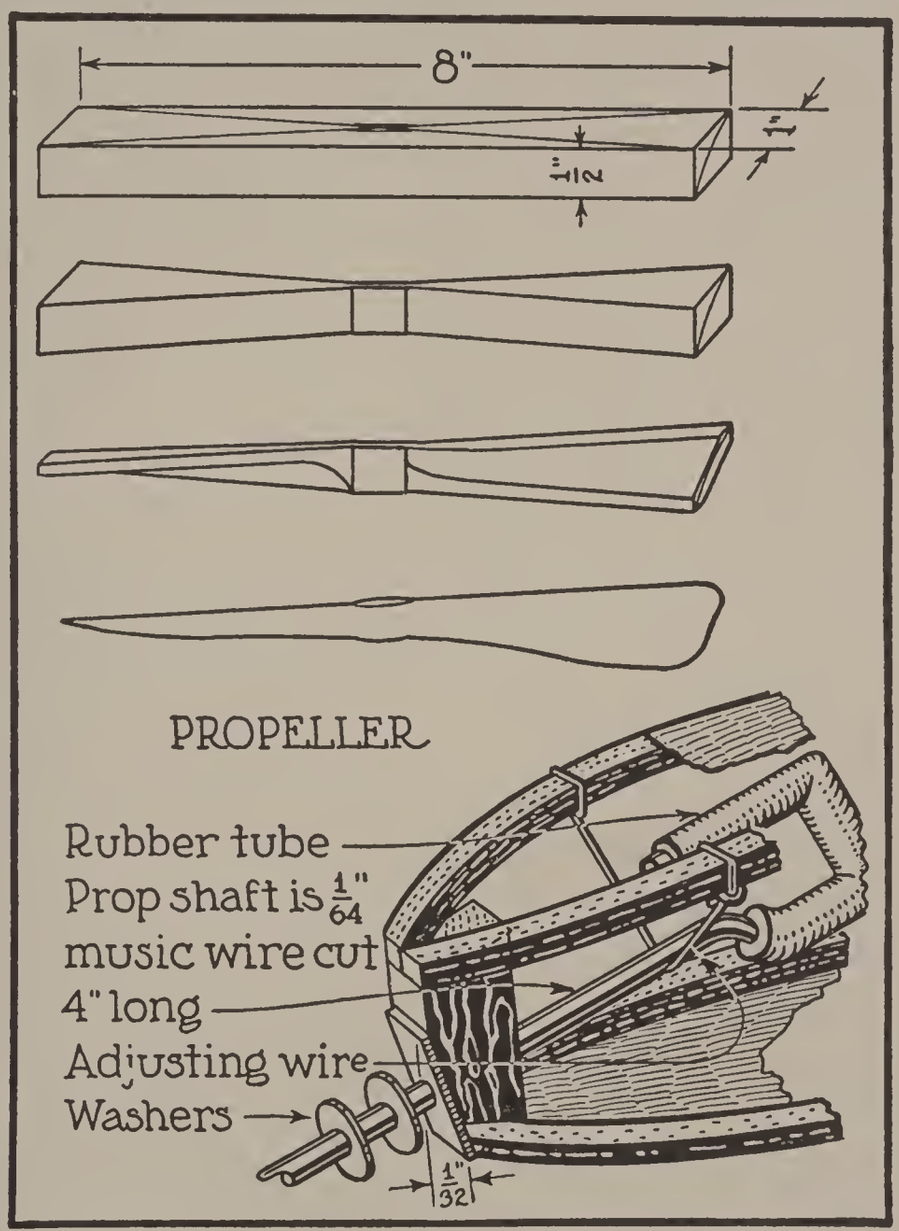


Now cement the nose ends of the longerons to a 1/8 by 1/4 by 5/8" nose post. Put three wraps of fine thread around them while drying. Be sure that the nose centers well, for if it points sidewise, the propeller will drag the plane around in short circles that waste the power and shorten the flights.

For the shaft bearing, push a brad through the nose post 1/4" from the lower edge, inclining it upward toward the inside. Trim the lower end of the post back $\frac{1}{32}$". Drill

a piece of celluloid ⅛ by ½" long, and cement it to this sloping part of the post.

Cover the fuselage with rice paper. Cut a strip for each side and glue it to longerons and struts with mucilage or



thin library paste thinly applied. Be sure it sticks well at all points, for the paper sheath must brace the frame to keep it from twisting. The ends of the sides must be left open for getting the motor in and out.

Trim the edges of the paper smooth with a razor blade,

and sand the corners of the nose and tail until round.

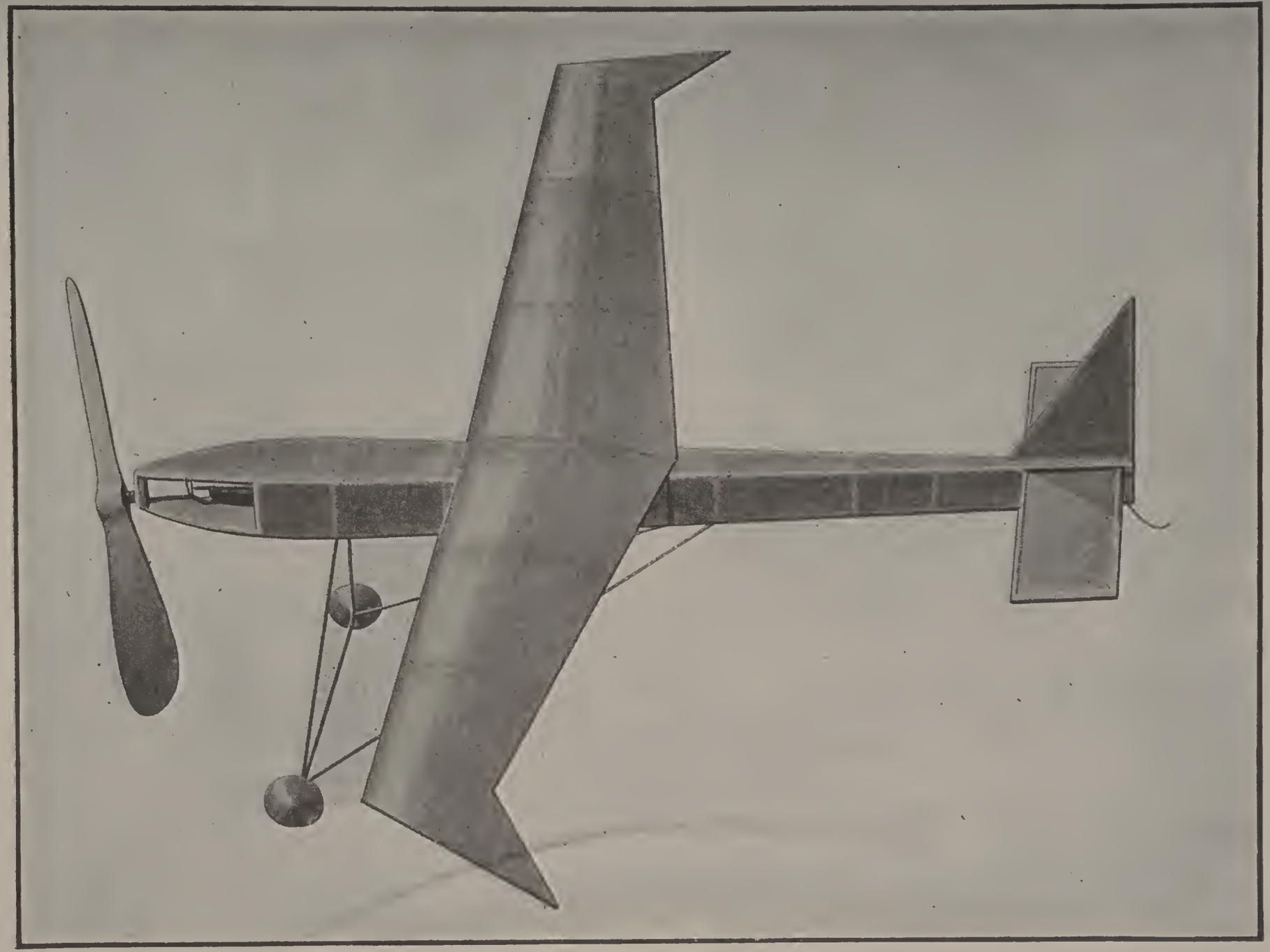
For the propeller use a piece of balsa ½ by 1 by 8″. Draw diagonals on both faces, and push a pin squarely through where they intersect. Draw lines parallel with the edges, centering on the width, ⅛″ apart, for the hub. Rip along the diagonal lines to the hub, and carefully chisel the waste pieces from it.

Carve the blades to $\frac{3}{16}$″ thickness. Then work out the backs until they are hollow, sanding them smooth. The fronts are then carved rounding, and are sanded until light can be seen through them from the tips nearly to the hubs. Trim the corners round, file the hubs to curve smoothly into the blades, and cut them away to a front-and-back thickness of ⅜″. Round the corners of this last cut.

The shaft is $\frac{1}{64}$″ piano wire cut 4″ long. Bend a motor hook on one end. Push the straight end through the bearing, from the inside, thread over it two or three small washers, and put it into the propeller hub. Bend a small hook on the front end, to be pushed into the hub and cemented.

The tail hook is a loop of wire put around the tail post; but it must not be cemented until the tail is in place. Bend an "S"-hook from the music wire, so that a winder can be used on the motor.

Use six strands of ⅛″ rubber for the motor, with the loops about ⅛″ longer than the distance between the hooks. Tie the ends with thread.



THE SEAGULL TRACTOR

To protect the rubber from being cut by the hooks, wrap the wire with thread or slip on short pieces of small rubber tubing, such as can be purchased at a model supply counter.

To build the wing, draw a pattern as was done for the fuselage. Make a rectangle 3 by 20″, dividing it in halves lengthwise. Measure along the leading edge 1″ from each end, and square back from the ends 2¾″, showing the length and angle of the end ribs. Mark a point 1⅝″ back from the leading edge at each end rib, showing where the trailing spar butts against it. Also locate the ribs, which are 3″ apart, starting from the center.

For spars cut two strips $\frac{1}{16}$″ wide from the $\frac{1}{16}$″ veneer. Lay them in place, holding them with pins at the edges. Break the trailing spar at the center and cement it together at the angle. Butt the end ribs against the ends of the spars.

Cut material for the other ribs ⅛″ longer than shown by the flat drawing. Roll a pencil on the under sides, which will curve them, the amount depending on the pressure. Notice that most of the curve is in the front ends, extending about one-third the way back, while the rest of the rib is nearly straight. Naturally, the center rib, being the longest, has the deepest curve.

Build the tail next. The trailing edge is mitered against the leading edge, and the lower piece butts between these two.

Attach the tail by cementing the lower piece to the upper side of the fuselage.

For the front wing stirrup, cut a piece of $\frac{1}{64}$" music wire 2" long and, centering on its length, bend into a square "U" $\frac{7}{8}$" wide. Bend the legs back and upward $\frac{1}{8}$" from the first bends, and $\frac{1}{4}$" from these bend into backward hooks. Cut off the remaining ends. Cement the hooks over the tops of the leading wing spar, at the center.

The back stirrup is $\frac{5}{8}$" wide and $\frac{1}{8}$" high.

To attach the wing to the fuselage, pass a strand of $\frac{1}{16}$" square rubber through one of the downward loops of each stirrup. Pass the rubbers under the fuselage and thread through the other loops, tying them there. Handle the plane carefully, for the parts are easily broken.

The pull of the rubber may warp the wing out of shape; but this is easily remedied by slipping wedges under one end or the other of the leading stirrup. The exact amount of "wash" to oppose the motor can be obtained in this way.

Draw the landing-gear pattern on a board and drive in nails where the wire is to bend. Use $\frac{1}{64}$" music wire, twisting the ends together at the back clip. Use pliers to get sharp bends, so that the straight parts will not be sprung into curves. Remove the wire from the form, bend it at the axle points, and twist the stirrups vertical. Cement the stirrups to the fuselage, the front forward of the bulkhead, the rear about $5\frac{3}{8}$" behind it.

Each wheel is made of two 1″ circles of writing paper, cut radially to the center at one point, with the flaps glued under to make the sides into cones. Glue the edges together for the rims. Thread a straight $\frac{1}{64}$″ wire axle 5″ long through the wheels, bend the ends up, and coat with cement to prevent the wheels from working off. Tie the axle to the struts with thread, and ambroid.

Bend a tail skid to push into the lower end of the tail post.

Try the plane for gliding with the wing about 4½″ back from the nose. If it nosedives, move the wing forward, and if it stalls, move it backwards. When a flat gliding angle has been obtained, mark the position with a pencil.

Now wind the propeller backward until a row of knots comes in the rubbers. Toss the plane lightly against the breeze. If it stalls, do not move the wing backward, since it is already adjusted for a good glide, but lift the back end of the propeller shaft with a fine wire fastened to the upper longerons and looped under the shaft. Adjust the shaft until a good flight is possible.

5

THE DIAMOND FUSELAGE R. O. G. PLANE

The trim little *Diamond Fuselage Plane* gets its name from the lozenge section of its body. The construction gives strength, lightness, and neatness to the model, and provides good mounting for the wing and stabilizer.

The materials needed for this ship are: For longerons, four pieces of 1/8 by 1/8 by 27″ balsa, and one piece 20″ long; for bulkheads, 1/8 by 2½ by 9″ balsa; for posts, one piece 5/8 by 3/4 by 2″; for wheels, one piece $\frac{1}{16}$ by 1 by 4″; for the wing, two pieces 1/8 by $\frac{3}{16}$ by 30″; for spars, and for ribs, a piece 36″ long; for tail, one piece 1/8 by 1/8 by 13″; for stabilizer, one piece $\frac{1}{16}$ by 2½ by 10″; for propeller, one piece 3/4 by 1⅝ by 10″; for stirrups, propeller shaft, wire struts, etc., 28″ of $\frac{1}{16}$″ music wire; for braces, 20″ of $\frac{1}{64}$″ music wire; also ambroid cement, 1″ brads, thread, one piece of aluminum $\frac{1}{32}$ by 1/8 by 1½″; rice paper 16 by 30″.

First make the three body bulkheads. Bulkhead "A" is 2½ by 3½″. The side notches are centered between the top and bottom notches. Lay out a shape on a rectangle of 1/8″ balsa, with the grain running lengthwise, and saw out the notches with a coping saw, or cut them with a razor

blade. Then cut the sides, next the inside, and finally the notches in the upper sides, which carry the false longerons.

The other bulkheads are made in the same way; but the side notches are nearer the upper notches than the lower. Notice the drawing of these parts.

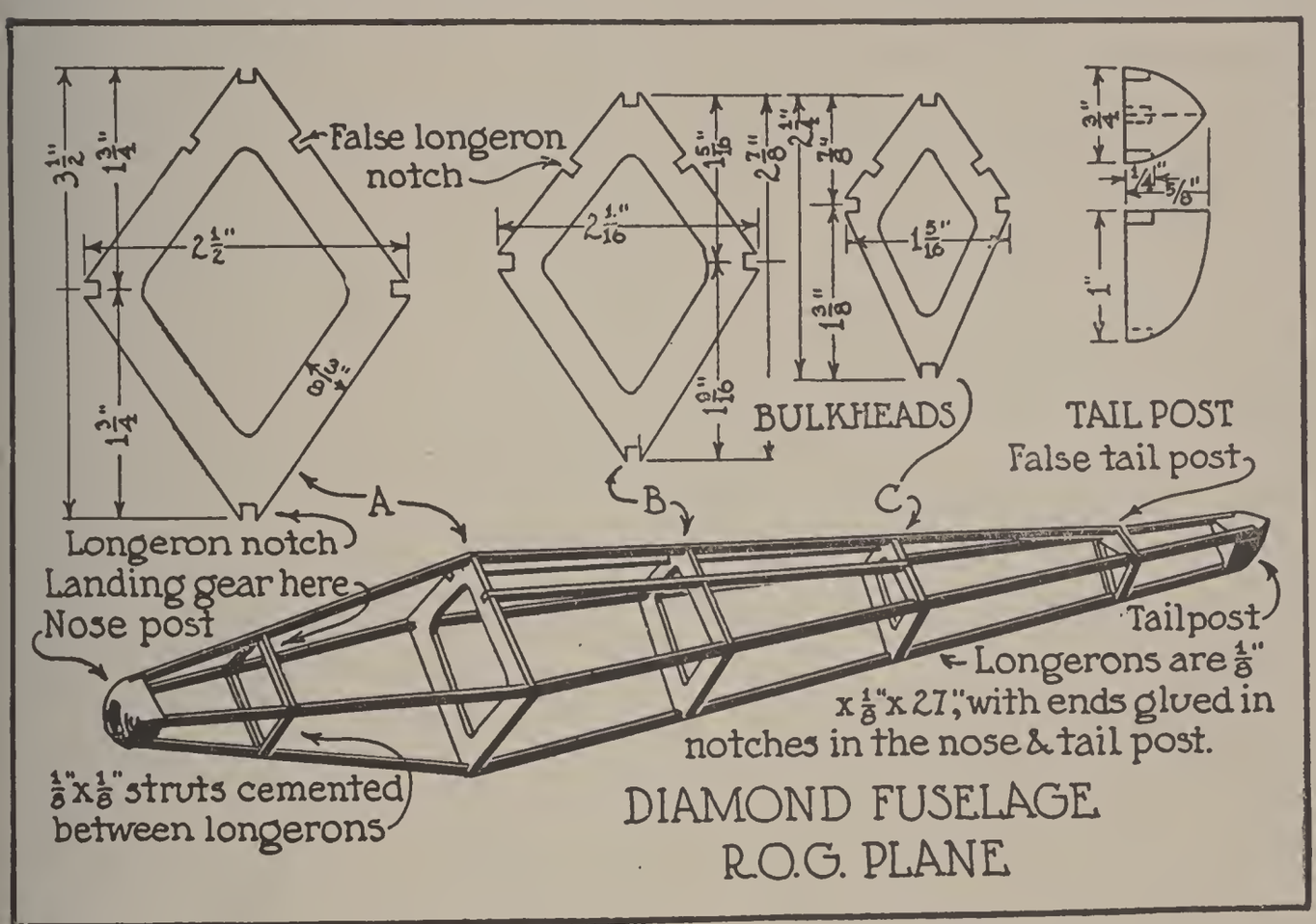
Make the nose post next. Cut the block ½ by ¾ by 1″, and round the front corners. Carve ⅛ by ⅛ by ¼″ notches in the sides, top, and bottom, to hold the ends of the longerons, and make a hole from front to back, ⅛ by ½″, through which to put the propeller-shaft hook.

The tail post is roundly triangular, ¾″ wide at the front top, and curving back to a point ⅝″ behind. Notch the upper and lower corners.

Lay the longerons together on the bench and mark the positions of the bulkheads and struts. Note that the bulkheads are 5″ apart, with "A" 3″ from the front end. Glue the side longerons to the bulkheads, carefully crack them at

"A," and glue their ends into the side notches of the nose post and of the tail post. Fill the breaks with cement.

Now add the upper and lower longerons, breaking them at "A" also, so that they will come straight to the nose piece. The upper longeron does not meet the tail post, but

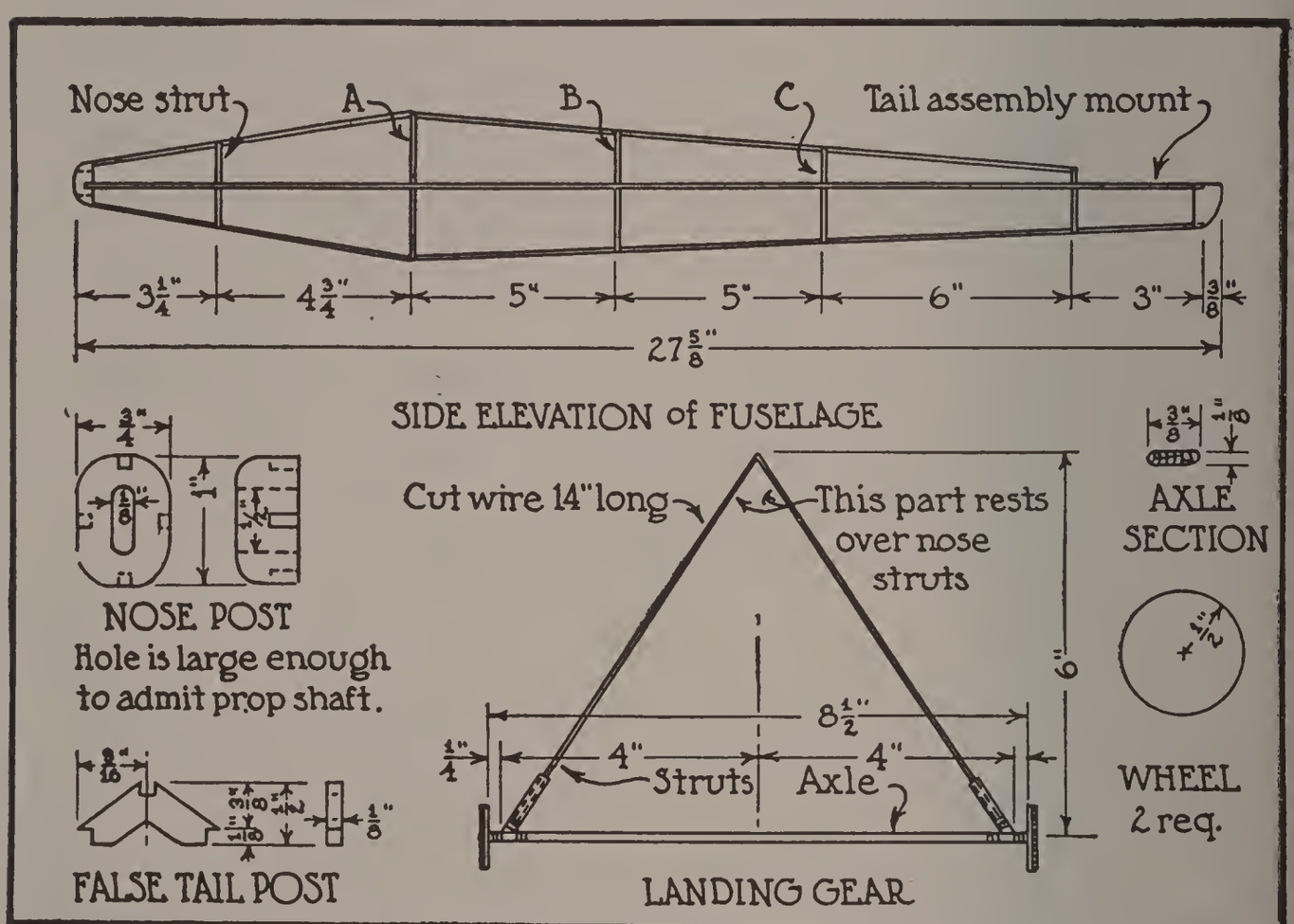


is 3″ shorter than the others, the end being held with a triangular false post detailed under the nose post drawing. This post notches around the side longerons, but is hollowed underneath to give more room for the motor rubbers.

Miter the ends of ⅛ by ⅛″ balsa sticks to fit between the longerons at a point 3¼″ from the nose. Also put struts between the side and lower longerons under the false tail post.

This construction gives a flat table for the mounting of the tail assembly, together with an angle back which wing stirrups can straddle.

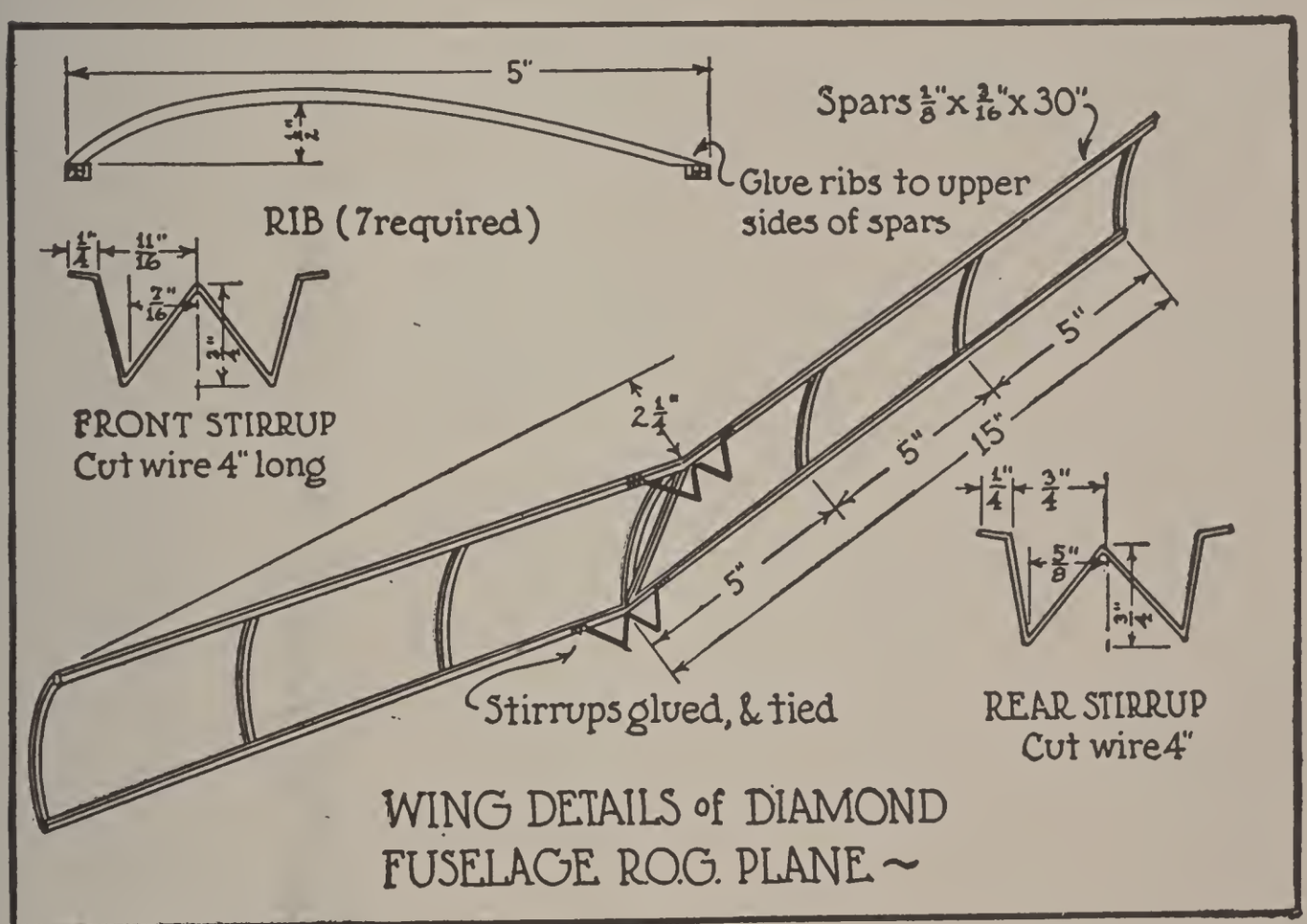
Trim the nose post to the taper of the fuselage when the cement is dry.



For each wheel glue together two 1″ squares of $\frac{1}{16}$″ balsa, with the grain of the pieces crosswise, to strengthen it. Cut the wheels 1″ in diameter, and push a small 1″ brad through each center, for a spindle.

The axle is ⅛ by ⅜ by 8½″ balsa, rounded on the ends and edges, and well sandpapered to reduce air resistance. Push the brad spindles into the ends.

The wire strut is a piece of $\frac{1}{16}$" music wire bent in the center, with a 2" length of balsa axle stock pushed over each end, cemented, and mitered to fit against the axle ¼" from the ends. Tie and cement the wood struts to the axle, and carefully straighten the wire. Cement and tie the strut point

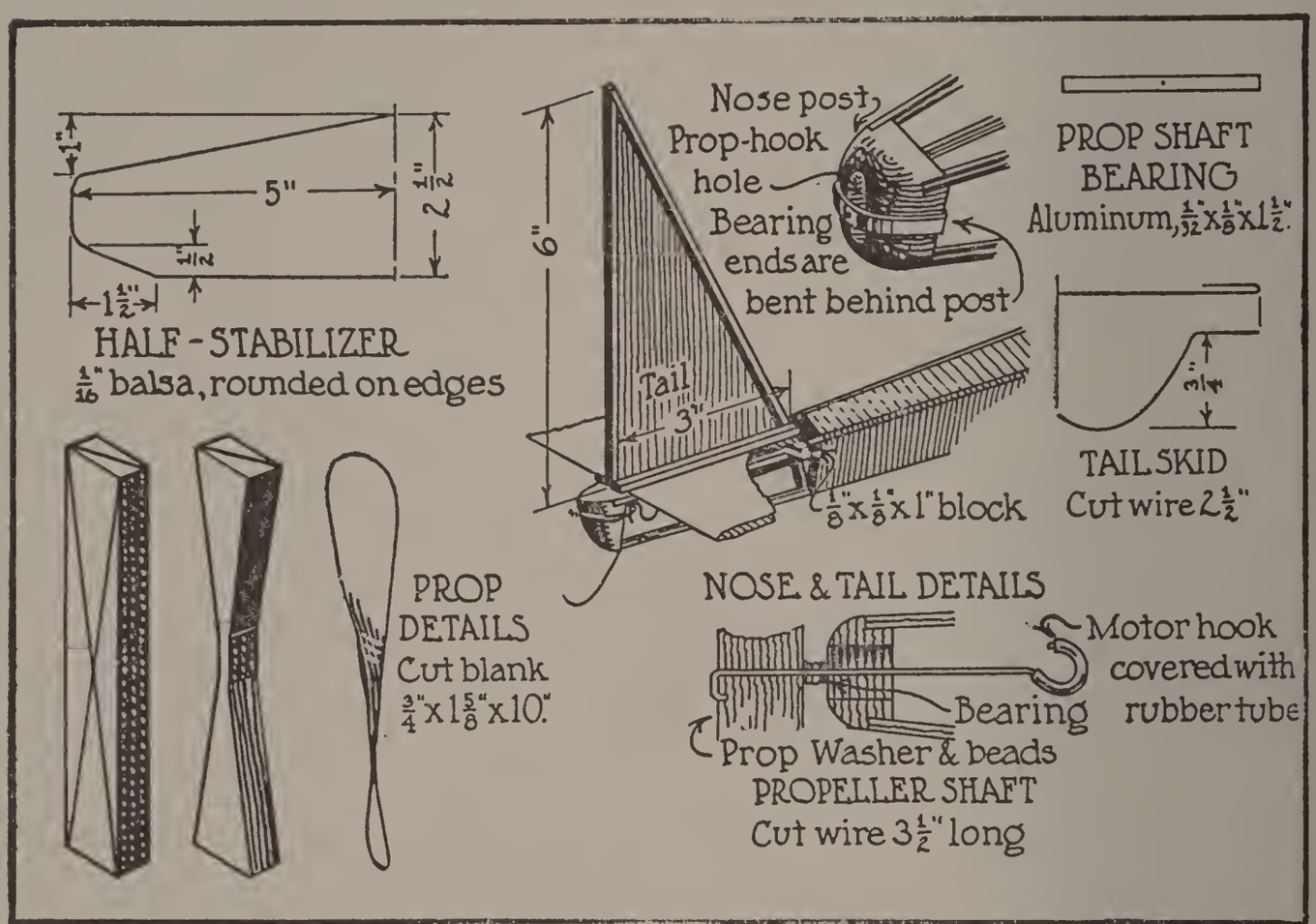


WING DETAILS of DIAMOND FUSELAGE R.O.G. PLANE ~

over the nose struts of the fuselage, looping the thread around the longerons, as well as the struts, to distribute the landing shocks to the whole frame.

It is not altogether necessary to brace the axle, but $\frac{1}{64}$" wire bent around the axle ends and brought up to the side longerons at bulkhead "A," will help keep the wheels "tracking" when the plane takes off from the ground.

If better wheels are wanted, cement a ¼" length of light metal tube in the center of each, which will prevent the spindle from crushing into the wood, making the wheel both off-center and wobbly. Such tubing can be bought at any store that carries model airplane supplies.



Inspect the fuselage carefully to see that there is a clear passage from end to end, beneath the side longerons, for the motor. If the bulkheads seem to interfere, trim the openings in the centers a little larger. Once assembled in the fuselage they are very strong, and can stand such reduction in size.

A good fuselage deserves a good wing, so make the gluing surface of this plane carefully. While the body holds

the other parts in position, and houses the motor, the wing gives the lift, and it can make or mar the performance of the plane.

Outline the wing on a board, providing for 30″ spars 5″ apart from outside to outside. Square cross marks for ribs every 5″. Drive brads or pins in the board to hold the spars.

Cut the rib stock 5⅛″ long. Lay the pieces on a magazine and roll a pencil on each, relieving the pressure as the trailing ends are approached.

When the ribs are bowed ½″, miter the ends until they will lie flat when cemented to the upper sides of the spars.

While the wing frame dries, shape the stabilizer. The leading edge tapers back from the center, and the trailing edge is tapered at the ends for 1½″. Round the corners, and sand the edges round.

Give the wing a dihedral angle of 2¼″, by breaking the spars beneath the center rib, filling the cracks with ambroid, and blocking the frame in position.

The drawings show clearly how to shape the wire stirrups. It is important that the ends fit the wing spars accurately, so that they will not alter the dihedral angle, nor warp the wing. There must be no accidental twists in the wing. Cement them beneath the spars, and when dry, bind with thread and cement again.

Cover the upper side of each half of the wing, cutting

the paper oversize, and gluing it to the outer edges of the spars and the tops of the ribs.

To cover the fuselage with paper, cut a strip, smear the outer edges of the longerons with glue, putting the paste on the bulkhead edges and struts as well, and stretch on the paper as lightly as possible. Trim to size when dry. The upper sides of the fuselage at the nose are left open, for convenience in handling the propeller shaft, and the lower sides at the tail are left open so that the "S"-hook can be drawn out to twist the rubbers with a mechanical winder.

The tail is triangular, 3″ wide at the base, and 6″ high. Use ⅛ by ⅛″ balsa for the uprights, with the upper ends butted and the lower ends glued in notches in the end of a $\frac{1}{16}$ by ¼ by 3″ strip.

Give one coat of dope to all paper covering. Prop the forward corner of the left end of the wing ¼″ high to give it greater lift in opposition to the twist from the motor. Glue a ⅛ by ¼″ strut under the center rib of the wing to further stiffen it.

Glue the trailing edge of the stabilizer to the tail post, and the leading edge to the longerons, but with a ⅛ by ⅛ by 1″ block beneath it to give it incidence. Tie with three or four wraps of thread sewn through the balsa.

Glue the tail base on top.

To carry the end of the "S"-hook, make a loop of fine wire around the tail post, and bend a light tail skid, with

the front end bent back on itself in a hook, forming a flat base to cement and tie to the under side of the lower longeron.

To carve the propeller, draw diagonal lines on the faces of the blank with parallel lines ¼″ apart at the center, for the hub. Flatten and slightly hollow the inner faces of the blades, then carve the front faces.

Bend a hook on the propeller shaft, as shown, and push the other end through the hub. Bend it into a hook, and push the tip into the front of the hub.

Drill a hole in the center of the aluminum bearing strip, and bend it around the nose. The ends clasp the back of the post. Cement it near the bottom of the hole through the post.

Slip over the shaft a small washer and two glass beads, or other washers. Put the hook through the bearing, wrap it with thread or cover it with a short piece of rubber tubing.

Make an "S"-hook for the tail, and install an 8-strand ⅛″ flat rubber motor.

Hold the wing on the fuselage with a piece of rubber looped through the stirrups and around the body. Pull the centers down and tie together with thread. When the proper position of the wing has been found by gliding, partly wind the motor and launch the ship against the wind.

The propeller in this position is adjusted for a slight downward pull to offset the front lift present when the plane is under power. If it is too low, raise the bearing, and if too high, lower it. A point should be found where the gliding position of the wing is correct for the power flight; but if not, raise or lower the hook end of the shaft by stretching a fine wire from the side longerons below or above it.

To gain more elevation, block up the leading edge of the plane a little, and readjust its position. If the plane circles to the left, with the rudder set straight, twist the wing flatter to decrease drag.

For the best flights a mechanical winder must be used for twisting the rubber.

6

AN R. O. G. BABY COMMERCIAL PLANE

Quite like a full-sized aeroplane is the *Baby Commercial Plane*. It has a wing spread of 30″, and a fuselage length of 27″. When properly adjusted, it flies beautifully.

The materials needed are these: For longerons and struts, four pieces of balsa ⅛ by ⅛ by 36″; one piece ⅛ by ⅛ by 12″; for landing gear and bulkheads, one piece ⅛ by ½ by 28″; for posts one piece ½ by 2 by 2½″; for wing spars, two pieces of ⅛ by ¼ by 30″ balsa; for ribs, one piece ⅛ by $\frac{3}{16}$ by 48″; for blocks, one piece ⅛ by ⅜ by 8″; for propeller, one piece ⅞ by 1¾ by 10″; for wheels, one piece $\frac{1}{16}$ by 1 by 4″; for propeller shaft, hooks, etc., $\frac{1}{16}$″ music wire 7″ long, and 7″ of $\frac{1}{64}$″ music wire, and two 1″ brads; ambroid cement, thread, wing dope, rice paper 15 by 30″; 1½″ of small rubber tubing; 16 ft. of ⅛″ flat rubber, for motor.

First make two bulkheads, "A," and "B.". Cut a 2⅛″ piece of ⅛ by ½″ balsa, and with a razor blade divide it into two ¼″ widths, notching the ends ⅛ by ⅛″. Cut four longerons 27″ long, so that the pieces trimmed off may be used for the upper and lower struts of the bulkheads.

For bulkhead "B," cement 1⅝" struts across the sides already made, the ends coming flush with the notches. Be sure the bulkhead is square. In assembling, the longerons fit into the corner notches.

Bulkhead "A" has sides 2" long, with upper and lower struts 1⅛" long.

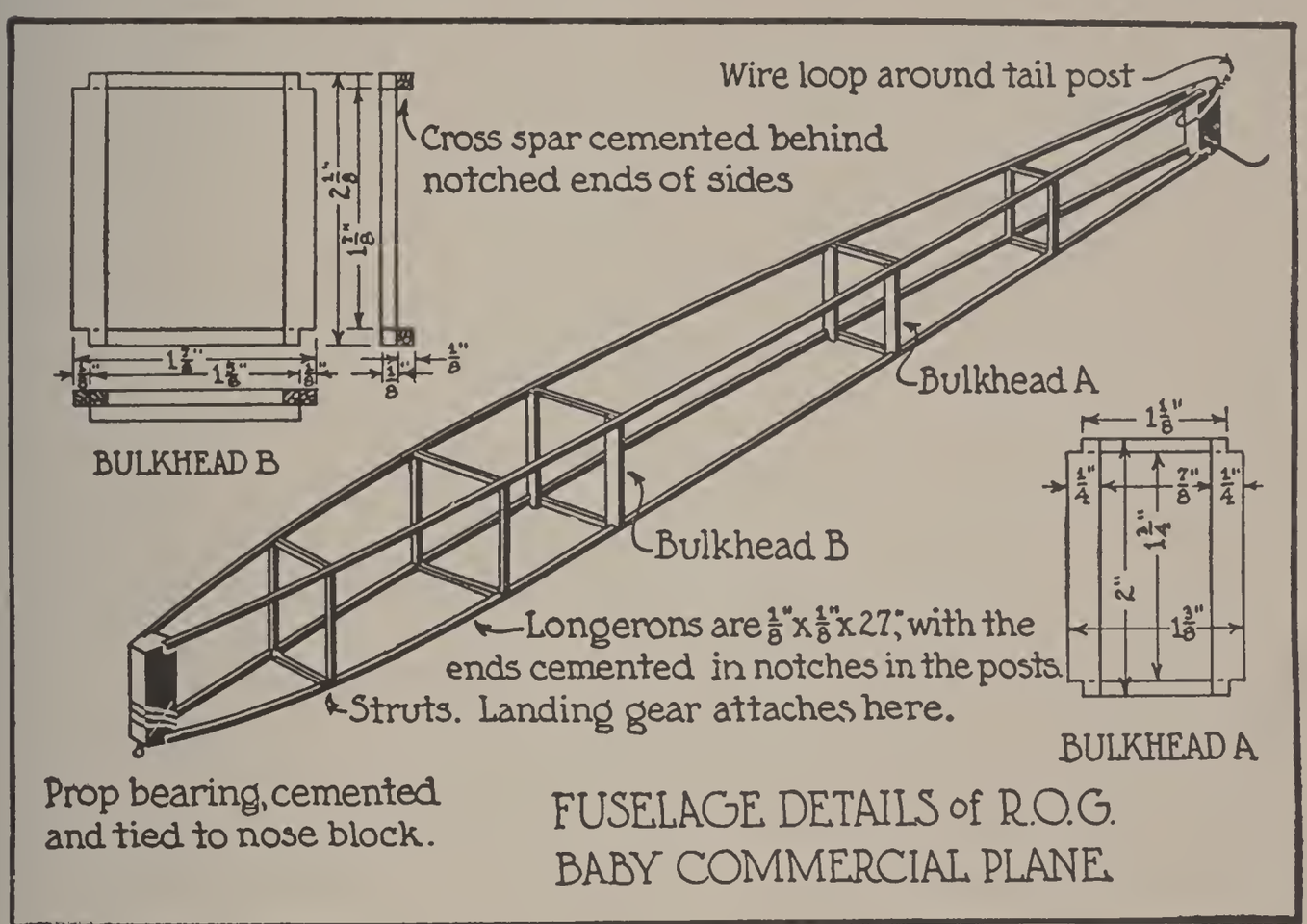
The nose post is $1\frac{5}{16}$" long. Use a piece of ½" square balsa, cutting it down to a thickness of $\frac{7}{16}$". Taper the thickness from front to back, making the front ¼" wide. The four notches are ⅛ by ⅛ by ¼", made to receive the ends of the longerons.

The tail post is $1\frac{3}{16}$" long, $\frac{5}{16}$" thick in front, and tapered back, with the trailing edge rounded. It is also notched in the ends to take the longeron tips.

Draw a plan view of the fuselage on a flat board. Lay out the center line 27" long, with cross marks where the struts and bulkheads go. The first mark, starting at the nose, is ¼" from the end; the next, 2½" beyond, and the next 3¼" farther on, and so on for the others, as shown in the drawing. The widths are also given there. Remember that these are outside dimensions. Drive brads in the board, just off the cross lines, with one outside and one ⅛" inside, so that the longerons can be laid between. In this way the

lower ones are held firmly in position during gluing up.

Put cement on the ends of the two lower longerons, and in the notches of the nose and tail posts. Push the longeron ends into the notches, slip a ½" block under the tail ends, and a ⅜" block under the nose. Be sure the posts are



FUSELAGE DETAILS of R.O.G. BABY COMMERCIAL PLANE.

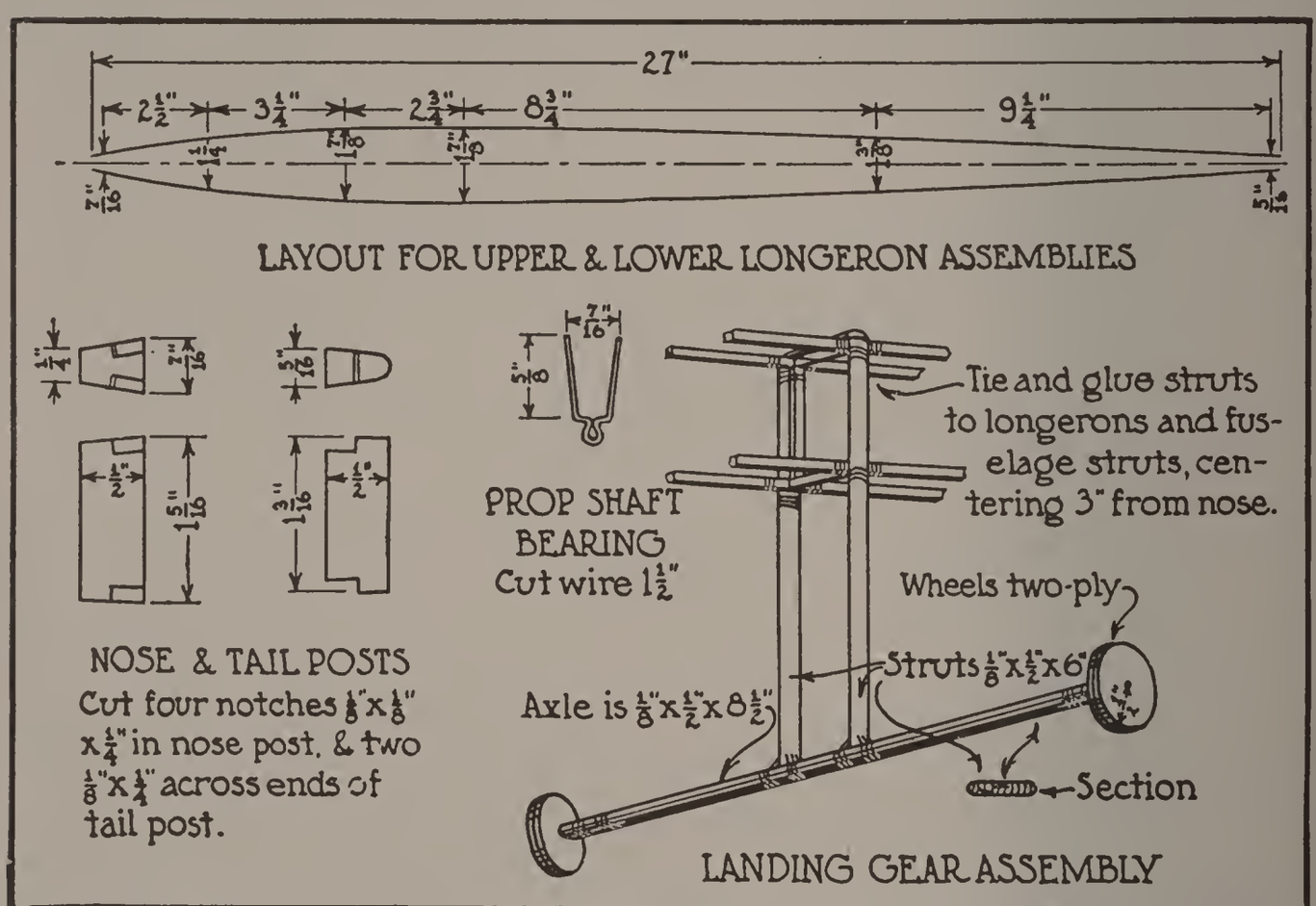
vertical, and that the centers, or rather the parts of the longerons under bulkhead "B," rest on the board.

Now cement the bulkheads in place, propping them upright until the glue is set.

It is now easy to glue the upper longerons into the notches in the posts and bulkheads. Cut a nose strut to fit between the lower longerons, and one of equal length to

glue between the upper ones. In the same way cut struts to go about midway between the tail posts and bulkhead "A." Also fit vertical struts between the upper and lower longerons. When the cement is dry, bend the nails in the board aside, and gently lift the fuselage from the form.

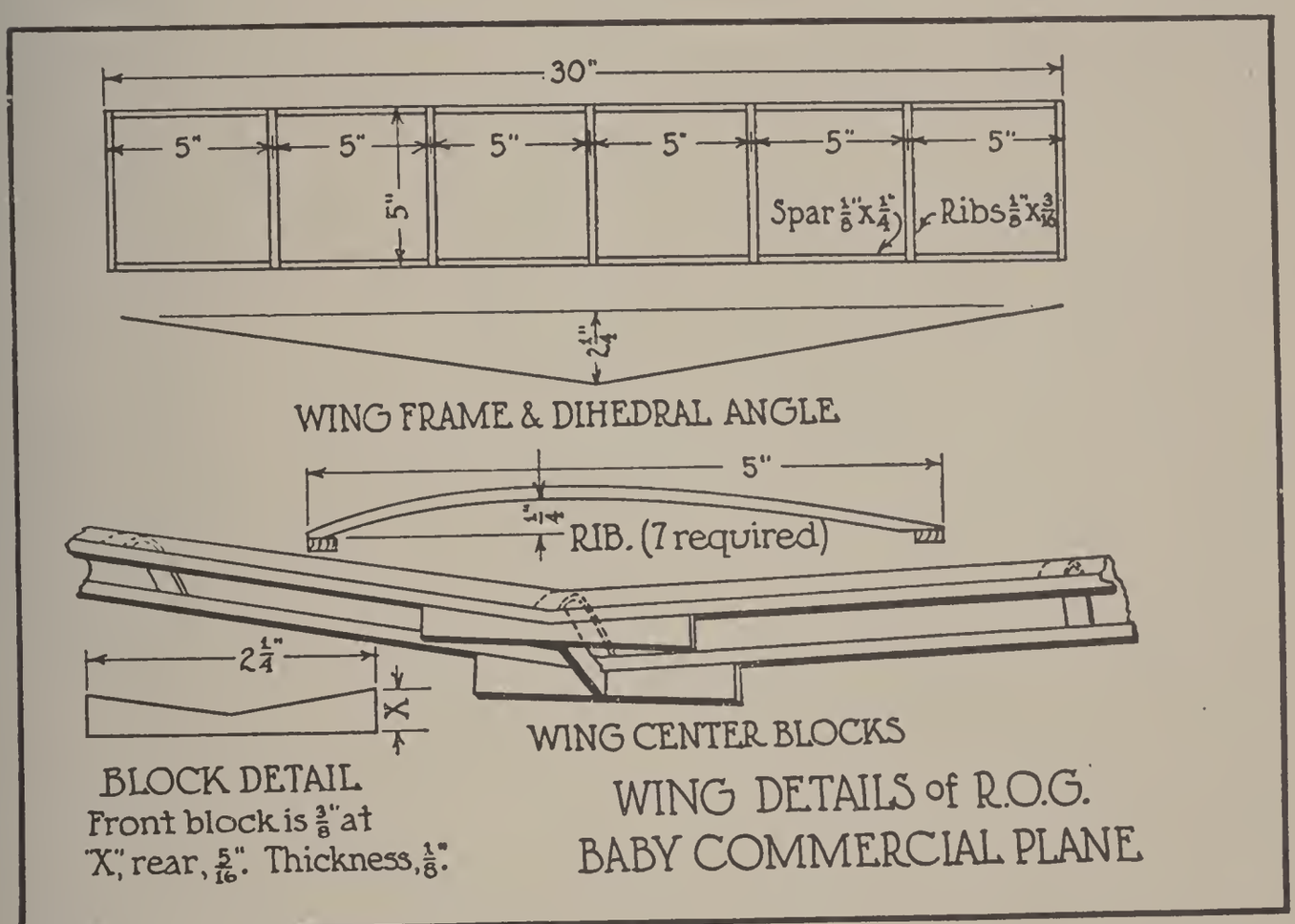
Now bend the propeller bearing. Make an eye in the



center of the heavy wire, by bending it around a brad. With small pliers bend the ends out behind the eye, and then back again, so that they will fit against the nose block when put in place as shown in the assembly drawing of the fuselage, that is, with the eye below the nose, and the ends diagonally across the sides. Bind with three or four wraps

of thread, and ambroid. When dry, carefully bend the eye until it is parallel with the nose post.

No tail hook is used. Instead, loop the fine wire around the tail post, so that it projects 1/8″ in front, and twist the ends behind, cutting off the surplus. Ambroid it at a point near the top.

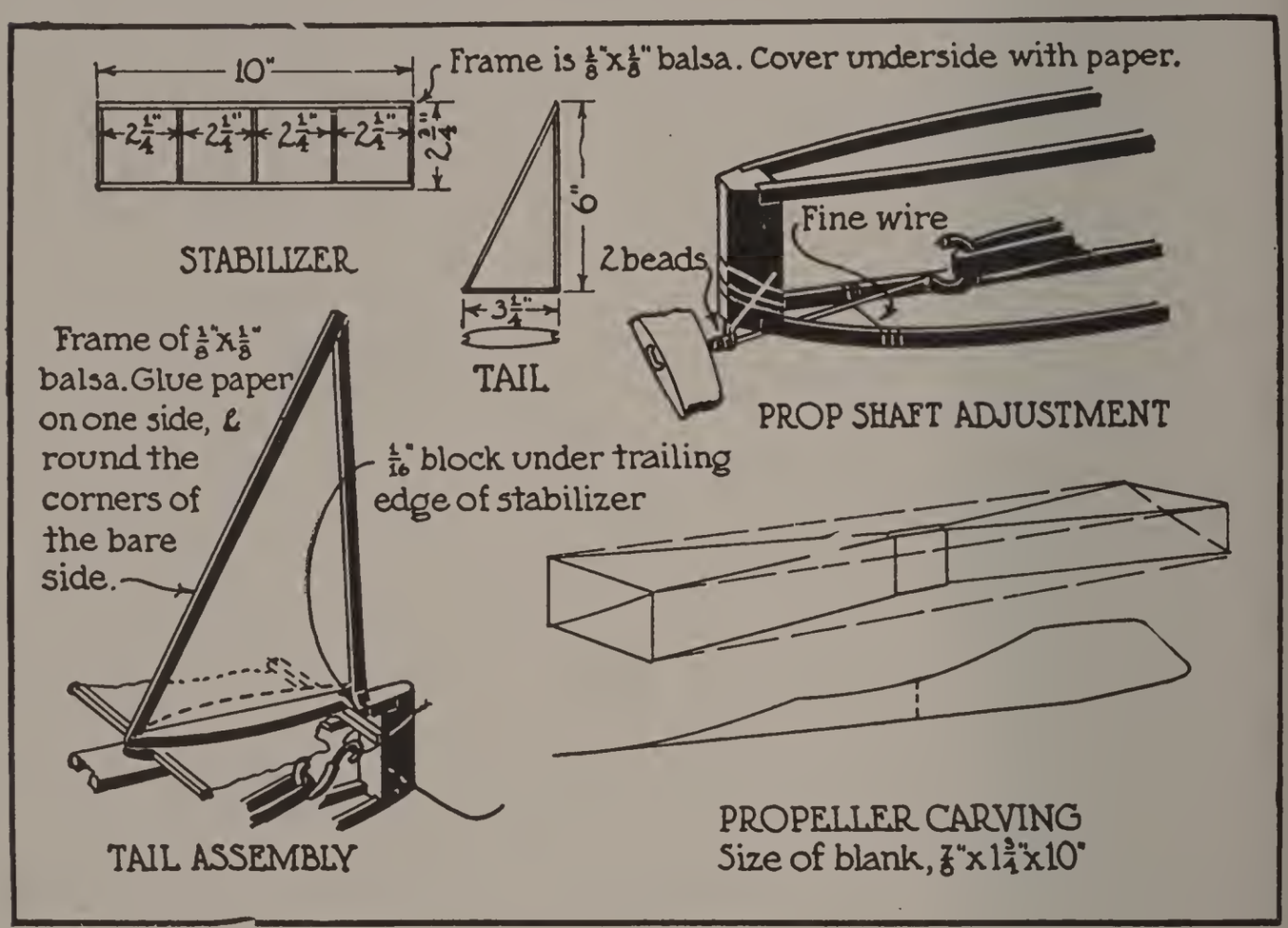


It is not necessary to cross-brace the fuselage to resist the twisting effect of the motor, since the paper covering is enough.

The landing gear is next. For each wheel cut two 1″ squares of 1/16″ veneer, and glue them together with the grain running at right angles. The wheels are 1″ in diameter.

The axle is 1/8 by 1/2 by 8 1/2", with the edges and ends rounded.

Push a 1" brad through the center of each wheel for a spindle. Ambroid the brad under an end of the axle, and wrap with thread, which is also glued.



The struts are made with rounded edges, and cut 6" long. Glue and tie them to the fuselage at the nose struts, and add a piece across the top for reenforcement. Glue and tie the lower ends to the axle. This is easily done if the thread is sewn through the ends with a needle, just as cloth is sewn.

The tail skid is a piece of light wire pushed into a hole

in the tail post punched with a needle, and bent into a broad hook. A touch of cement will hold the skid tight.

In making the wing, it is well to draw the outline on a board, and to hold the spars with a few brads or pins driven each side. Cut the ribs $5\frac{1}{16}$" long. Lay them on a $\frac{1}{4}$" stack of newspaper, and roll a pencil over one side, pressing down firmly at one end and gradually decreasing the pressure. This gives camber to the wing. The curve is $\frac{1}{4}$" deep at a point about one-third the way back from the front. Trim the rib ends so that they will rest flat on the tops of the spars, where they are cemented.

Gently break the spars at the center rib, block the frame with the ends $2\frac{1}{4}$" above the center, ambroid the breaks, and let dry.

Make the center blocks. These are cut from $\frac{1}{8}$ by $\frac{3}{8}$" balsa, and the upper edges are notched to fit under the wing spars, to hold them at the dihedral angle. The rear block is cut down to $\frac{5}{16}$" in width, which gives the wing an angle of incidence when in place on the fuselage.

Cover the upper surface of the wing, one-half at a time, with rice paper. Cut the paper large enough to leave finger holds at sides and ends. Glue to the front edge of the leading spar, coat the tops of the ribs, draw the paper smoothly over them, and finish by cementing to the trailing edge of the plane. Cover the other half in the same way, and trim the paper to the frame.

Glue a 1/8 by 1/4" balsa strut between the blocks, beneath the center rib, to prevent their being pushed over in flight.

Cover the fuselage with paper, from nose spars to tail struts. The ends are left open, so that the rubber motor can be adjusted and wound. Cover one side at a time, trimming the edges smooth before the next side is covered.

The stabilizer frame is flat, with straight ribs glued on the under side and covered with rice paper.

The tail is a right triangle, 3 1/4" on the base and 6" in height. Notice that the upright pieces are 1/8" square balsa, with the lower ends glued in notches in the end of a base streamlined from 1/8 by 3/8" balsa.

Give all paper one coat of wing dope. Prop the wing with the leading corner of the left end 1/4" higher than the other, giving the wing "wash" to resist the propeller torque.

Cement the stabilizer to the top of the tail end of the fuselage, with a 1/16" block under the trailing edge. Cement the base of the tail to its center.

The wing is held by a scrap of rubber band strecthed around the center strut and the body. The flying position is about 9" back from the nose.

The propeller is carved with the blades 1/16" thick, having the ends rounded at the corners. Cut out the hub 1/8" at the back.

Bend the hook on one end of the propeller shaft, and push the other through the propeller hub. Bend the end

into a small hook to push into the wood. Slip on a washer and two glass beads, or other washers, and pass the hook through the bearing. Cover the hook with rubber tubing.

Make an "S"-hook for the rear end, and put tubing on the motor hook.

Use eight strands of rubber in the motor, making the skein long enough to sag a little between hooks.

The plane is now ready for flying. Glide it until the wing is properly adjusted. If it settles back on the tail, move the wing backward; but if it nosedives, move the wing forward.

For a trial flight, wind the propeller backwards until a row of knots appears, and toss it lightly into the breeze, pointing about level. If it dives, adjustment of the propeller is very likely necessary.

It will be seen that the propeller is lower than the tail hook, so that it pulls downward a little. With the propeller shaft inclined downward at the proper angle, the power flight will be made with the wing in a good position for a long glide.

It is easy to adjust the propeller by stretching a fine wire above or below the shaft, tying the ends to the fuselage.

If a winder is used, long, beautiful flights are possible with this model.

7

BUILDING THE FREIGHTER

The *Freighter* is just what its name indicates—a reliable flier, strongly built, with a good landing gear that takes up hard landing shocks. It rises quickly to a fairly high altitude, and the motor unwinds practically at its "ceiling," leaving the plane high for a slow glide to earth.

These materials are needed for the plane: For the wing, four pieces of balsa 1/8 by 1/8 by 30″, used for spars, and for ribs, $\frac{1}{16}$″ balsa 1 by 46″; for stabilizer and tail, one piece 1/8 by 1/8 by 24″, and one piece 30″; for longerons and struts, two pieces of balsa 1/8 by 1/8 by 24″, and a piece 30″ long; one piece 1/8 by $\frac{3}{16}$ by 24″; for landing struts and axle, three pieces of bamboo $\frac{1}{16}$ by 1/8 by 12″; for wheels, balsa $\frac{1}{16}$ by 1 by 4″; for the propeller, balsa 1 by 1¾ by 12″; for propeller shaft, hooks, etc., $\frac{3}{64}$″ music wire 6″ long, and $\frac{1}{32}$″ wire 8″ long; aluminum $\frac{1}{16}$ by $\frac{3}{16}$ by 1¾″; also rice paper 15 by 30″, and 8 by 20″; pins, brads, thread, ambroid cement, and dope.

First shape the ribs. Carefully draw the pattern on thin cardboard, using a rectangle 7/8 by 5″ for a base. The upper curve comes to full height 2″ from the landing end, and

slopes gradually back, reversing a little as it nears the trailing end. The under curve, being more nearly the arc of a circle, reaches its high point a little behind that of the upper curve. It reverses and is even with the base line for ½". This form of curve gives a fair amount of lift to the wing, yet smooths the air currents as they leave the surface, reducing the eddies.

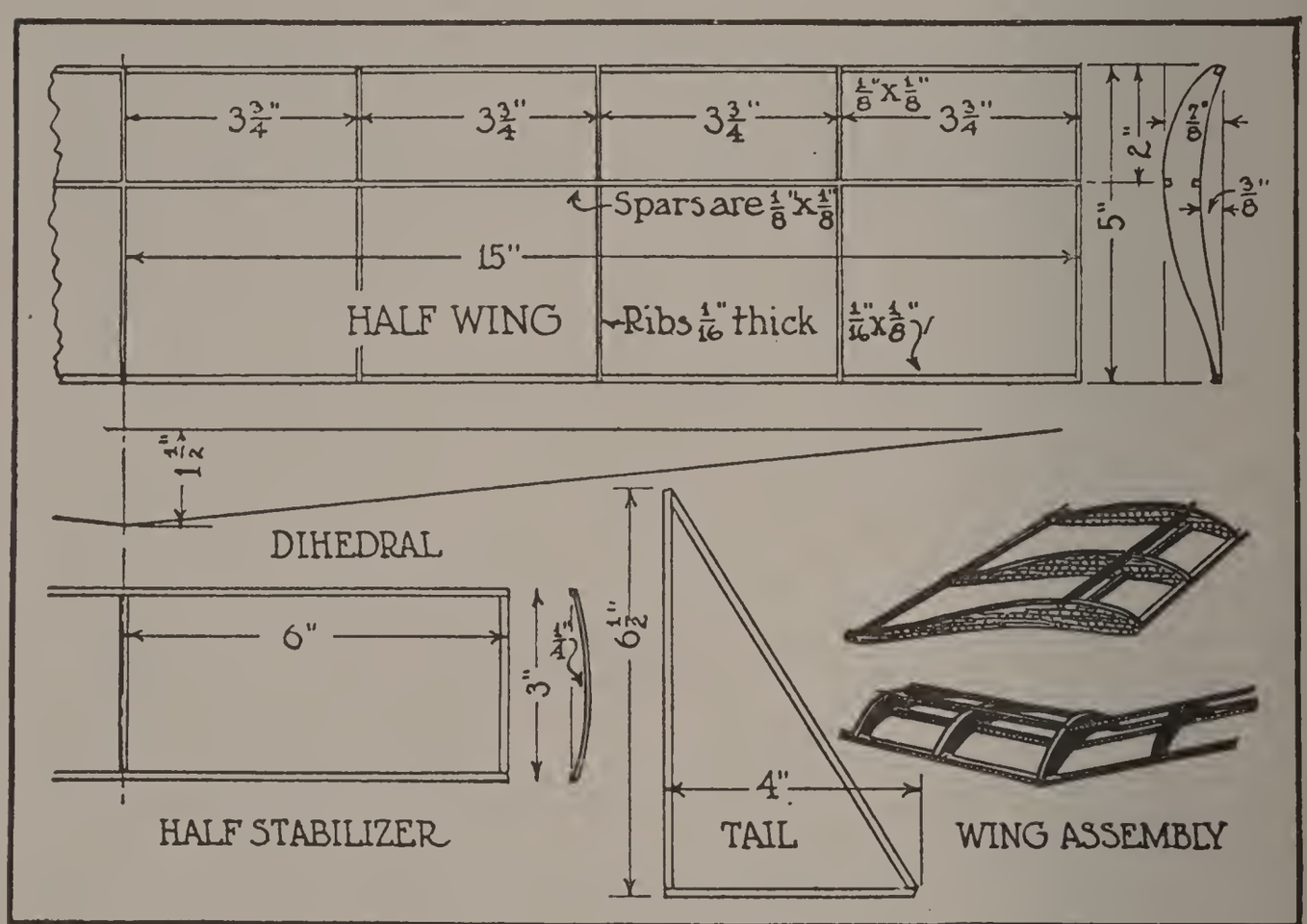
When the pattern is well shaped and cut out, clip ⅛" square notches above and below, and in the nose, with a fourth notch at the back end $\frac{3}{32}$ by ⅛". Trace nine ribs on the $\frac{1}{16}$" stock, and cut them out with a razor blade.

Cut four spars to length, sanding them smooth. The trailing spar is thinned with sandpaper to a thickness of $\frac{3}{32}$". Lay them side by side to mark the rib positions centering 3¾" apart.

Glue the leading and trailing spars to the ribs, putting glue on the notches and spars as each one is added. Be sure the frame is held square with pins or brads until dry. Cement the upper spar in its rib notches, and add the lower. This construction is strong and light in weight.

The wing has a dihedral of 1½". To make the bend, clip the upper spar at each side of the center rib, clean out

the notch, crease the other spars at the center so that they will make sharp angles, and draw the open ends of the upper spar together. If this does not give enough depth to the dihedral, trim a little more from each cut end. Glue the cut ends together in the rib notch, and tie with a few



turns of thread sewed through the rib with a needle.

Quite a little time is needed to cover the wing with paper, and for this reason it is easier to use a slow-drying adhesive, than the celluloid glue. Mucilage, library paste, or even paste made from flour (which is very light when dry) is good. Cut four 15¼″ strips of paper 5¾″ wide. Spread paste thinly with the finger tip along the front edge

of the wing, lay one sheet of paper over the top, and press the edge smoothly along the spar, drawing it lengthwise. Apply paste to the ribs, and to the back edge of the trailing spar, and draw the paper smoothly down. Cover the other half the same way.

Paste must be applied to the under edges of all ribs, and the paper pressed well against them. Pull lengthwise, but not crosswise, as this would draw it away from the under camber.

When the paste is dry, give both surfaces a coat of dope, and trim off all projecting paper, smoothing the edges lightly with fine sandpaper.

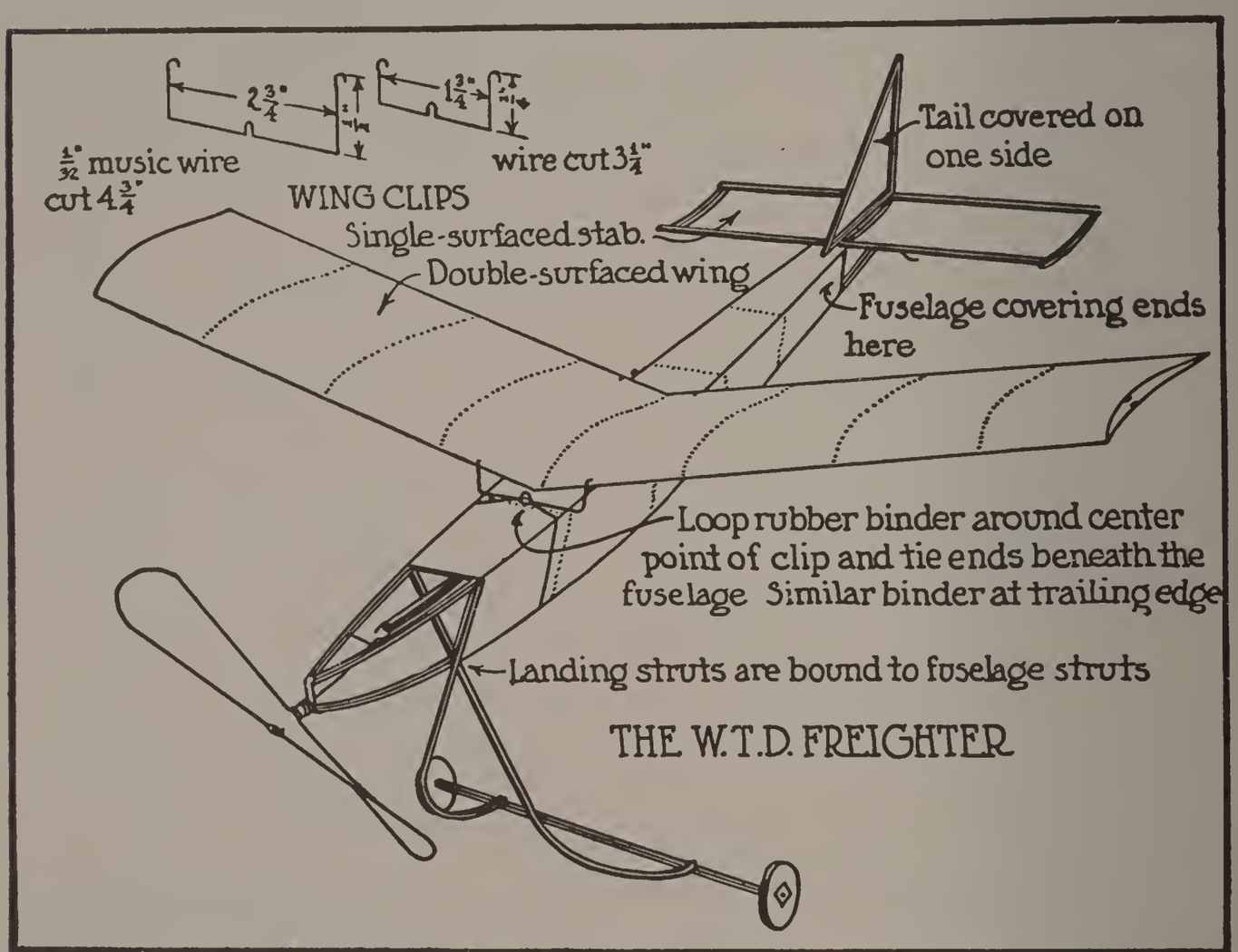
Nothing is said about "wash," or twist in the wing to offset propeller torque. If the builder wishes to make sure of such twist, he may block the wing in position while the dope is drying; but without any blocking there is likely to be enough warp to one side or the other, and the propeller can be carved right- or left-handed, to suit.

Clips must be made to hold the wing to the fuselage. Use $\frac{1}{32}$" music wire. Bend a $\frac{1}{8}$" hook on the end of the wire, to clasp the upper side of the front spar. Leaving $\frac{1}{2}$" for the vertical leg, bend the wire at right angles. Bend an upward loop about $\frac{3}{16}$" high at the center of the horizontal part, continue the latter, and make the vertical leg and hook that completes the clip. Cut off the surplus wire.

The rear clip is $1\frac{3}{4}$" wide and $\frac{1}{4}$" high.

Hook the clips over the leading and trailing spars, cement them, and bind with thread, cementing once more.

The stabilizer spars are 1/8 by 1/8 by 12″, sanded with rounding corners. Cut the ribs 3 1/8″ long and roll them on the under sides with a pencil, full length, curving them to



the arc of a circle with a depth of camber of 1/4″. Miter the ends, and cement them to the spars.

Cover the rib-side with paper, but do not dope. At the most, only shrink the covering with a light spray of water, as the frame may be warped out of shape if varnish is used.

Build the triangular tail of 1/8″ square balsa, and cover

one side with rice paper. Mount this on the center line of the stabilizer, cementing it and pushing a pin through the trailing spar of the stabilizer into its vertical spar, and through the leading spar into the forward point of the tail.

In building the fuselage, first draw a center line for the top frame 23½″ long. Draw lines across it for the strut positions, one 2″ from the nose, the second 3½″ behind it, and so on, as in the drawing. Cut the struts to the lengths shown, and lay them in place, with a pin through the center of each into the board.

Cement the ends of the two ⅛″ square longerons, tie them together with thread, and lay them on the board, putting a pin through the joint to hold it at the nose point. Apply cement to the ends of the struts, and the parts of the longerons that touch, and draw the longerons together against the struts. Hold the tail ends with pins outside them until dry, when the frame can be raised from the board by slipping a knife blade between them.

Cut a tail post from the ⅛ by $\frac{3}{16}$″ material, ¾″ long, which is cemented to the top frame.

The bearing strip is next. Cut a piece 1¾″ long, and drill it ⅝″ from one end for the propeller shaft. Bend ⅜″ of each end back, and curve the strip outward with the crown at the bearing hole. Bind this bearing hanger to the nose of the top frame, and the completing of the fuselage is in order.

The depth of the body is 2″. Cut a wooden block to this width. Lay the upper frame upside down on the board, and cross it with the block, which is clamped or tacked in this position.

Now hook the end of the 1/8 by $\frac{3}{16}$″ longeron under the bearing hanger end, cement it, and bind with thread. Draw the other end down to the tail post, where it is cemented

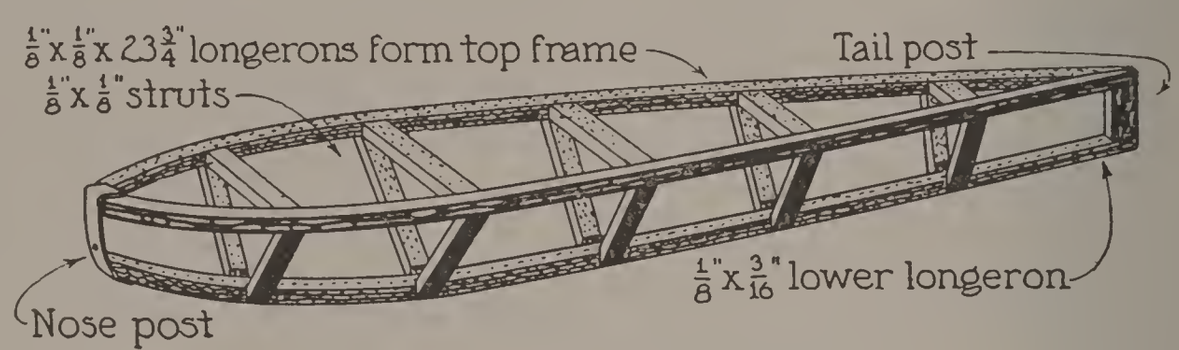
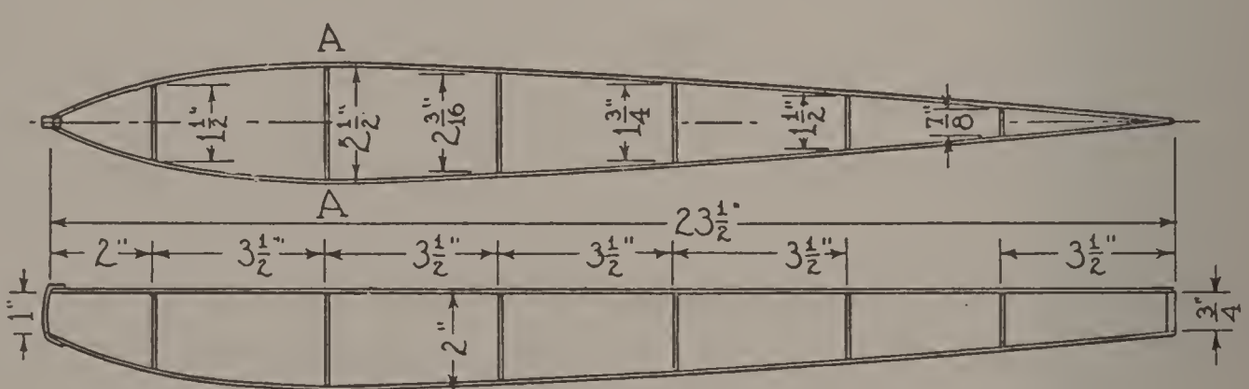
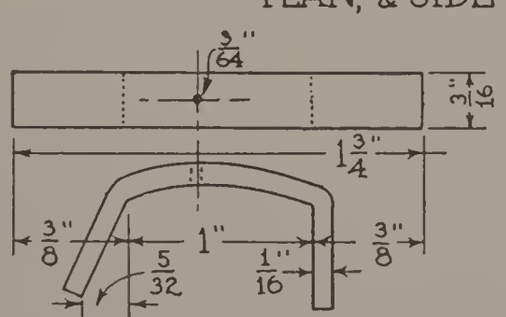


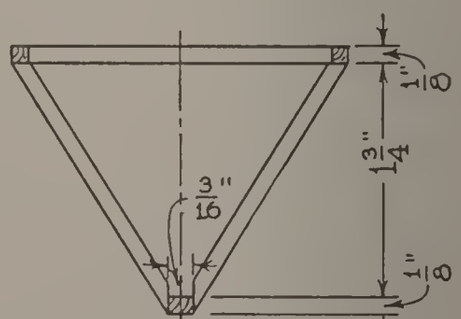
DIAGRAM OF BODY ASSEMBLY



PLAN, & SIDE ELEVATION of FUSELAGE



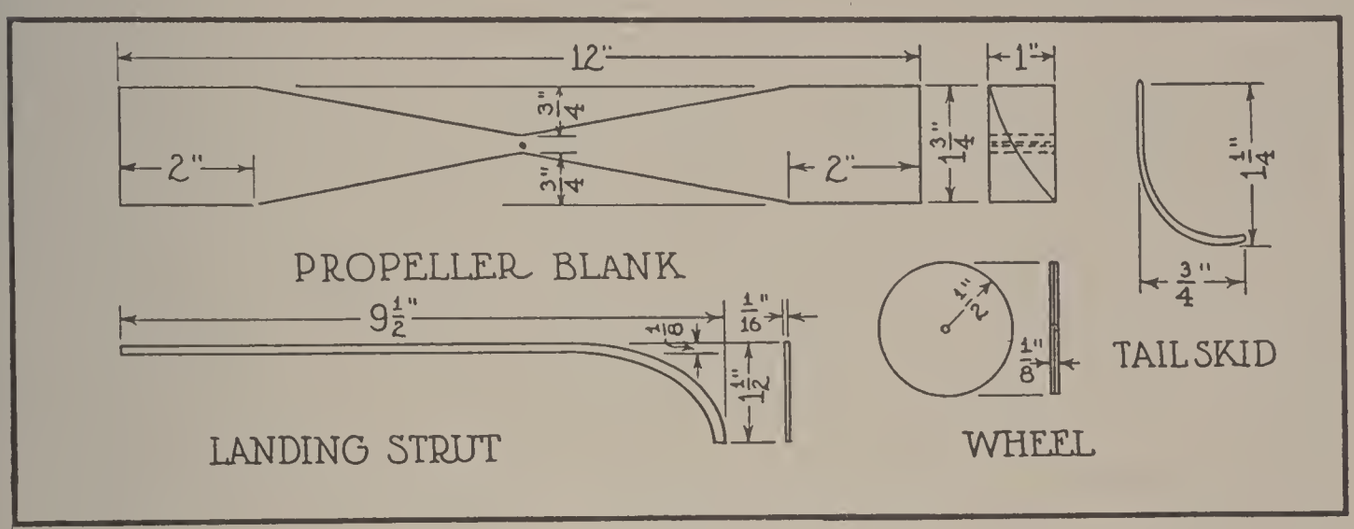
NOSE POST (Aluminum)



SECTION THRU A-A

and pinned. Be sure, after this, that the heavy longeron is exactly above the center of the upper frame.

Cut struts to fit between the longerons, with the same spacing as those of the upper frame. Ambroid them well, and let them dry before taking the body up.



Cover each side of the fuselage separately with paper, gluing it to the longerons and ribs or struts. The nose and tail must be kept open for inserting and repairing the motor.

Give the skin one coat of dope.

The landing struts are bent by steaming them over a kettle spout, with the glossy side out, or they can be formed by soaking in water all night and pinning them in position until dry, or by holding them, while wet, over a flame, bending them a little at a time.

Cut the pieces about 9¼″ long after bending, and tie them together to form an "X," with the crossing 2½″ from the upper ends. Straddle under the fuselage, and bind to

the front struts, being sure that the bent ends are on a line at right angles to the body. Cement the bindings.

Cut the axle 10½″ long and cement and bind it to the bamboo struts.

For the wheels, glue two 1″ squares of $\frac{1}{16}$″ balsa face to face with the grain at right angles. Draw 1″ circles and

cut out the wheels. Push a small brad through the center of each, for a spindle, which is cemented and bound to the axle end with thread.

To carve the propeller, smooth the faces of the blank, and of course see that the edges are square. Draw a line

across the center of each face, and one 2″ from each end. Draw lines from the end lines to points ¼″ each side of the center, and saw along them. Carve the insides ⅛″ hollow at the widest parts, and work down the outsides of the blades, leaving not more than $\frac{1}{16}$″ at the ends.

Shape in around the hub, and cut away the back about ¼″, tapering to the full width of the blades.

This does not make a true-pitch propeller, but it is very efficient for this plane.

Bend the propeller-shaft hook, thrust the straight end through the propeller hub, bend a hook in it, and push it into the hub front, where it is cemented. Make two or three aluminum and celluloid washers, slip them over the shaft, and put the hook through the bearing.

Make an "S"-hook, and loop a hairpin or other small wire around the tail post near the top, to take the hook.

Use ten strands of ⅛″ flat rubber for the motor, allowing very little slack between hooks. Slip it through the fuselage, and install.

The tail-and-stabilizer assembly is cemented to the top of the body, with a ⅛″ block under the trailing edge of the stabilizer to make it negative. The hollow side, of course, is up. A pin pushed through the leading spar into the upper longerons, and cut off flush, makes the assembly solid and strong.

The wing position is about 6″ from the nose. Tie a

rubber band around the fuselage here, and another 5″ behind. Put the wing in place, and lift the rubbers over the center loops of the clips to hold the wing.

The plane is ready for test glides, and two or three adjustments of the wing fore and aft should be enough to get a long, flat glide and a three-point landing. To protect the tail end of the fuselage push a pin into the under edge, bend it back, and cut off the head.

Now wind the propeller by hand until the first row of knots shows, and cast it into the wind. If it stalls, or climbs at too steep an angle to be efficient, raise the hook-end of the propeller shaft by looping under it a fine wire, to be tied to the upper longerons. A little adjustment of this will keep the plane from stalling, without spoiling the final glide by pushing the wing back on the fuselage. A word of caution, however: Do not point the propeller too steeply downward at first or the ship may go into a bad nose dive and crack up. A stall will seldom "take a crate to pieces," but a bad nose dive is almost certain to do so.

You will find that the plane flies well if only wound by hand; and actually it will perform well with eight strands of rubber. But the ten are needed if a winder is used.

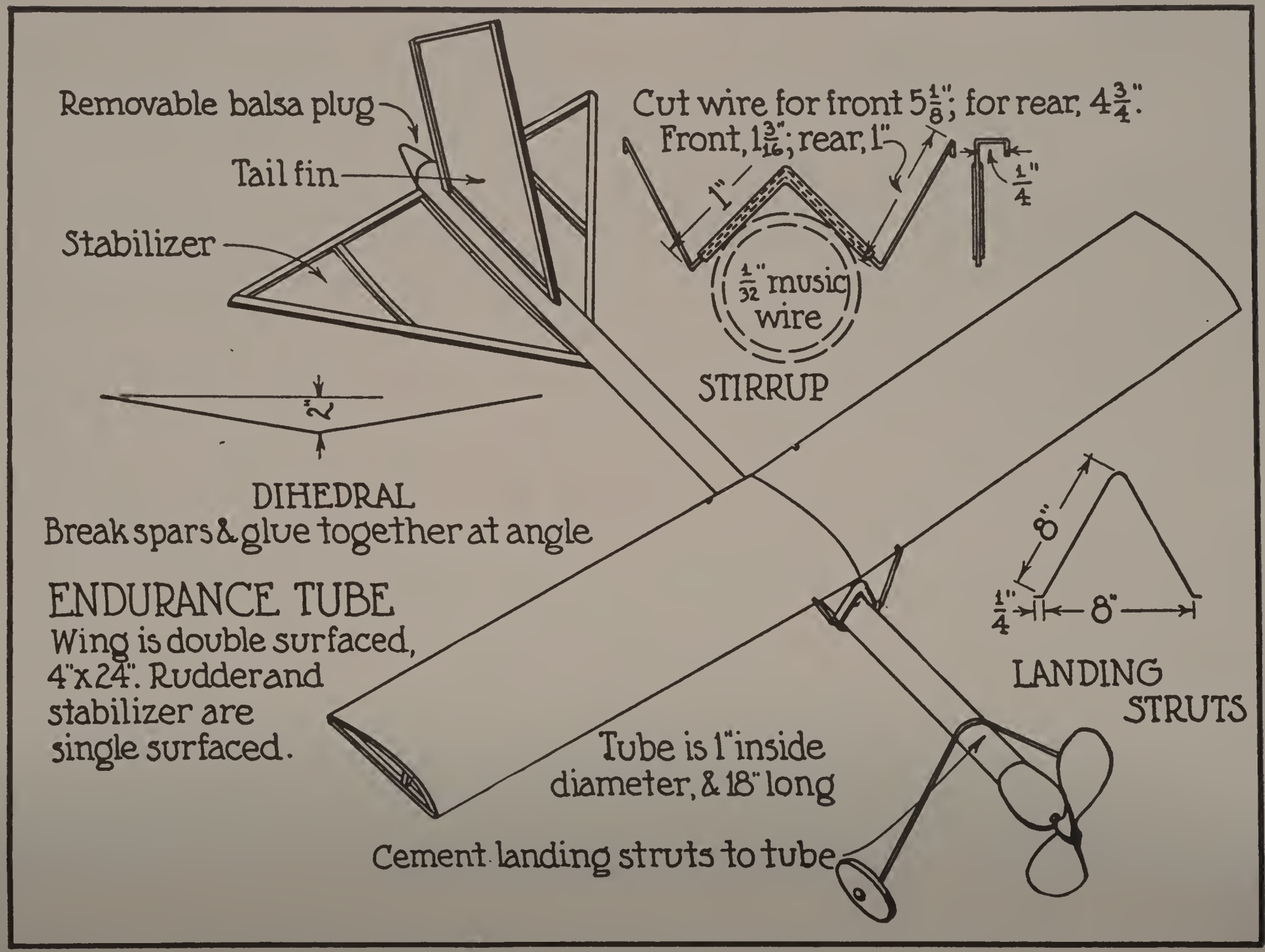
8

THE ENDURANCE TUBE MONOPLANE

Designed for endurance flights and trim appearance, the *Endurance Tube* makes good in every respect. It looks very simple to build, and in fact is; but careful workmanship is needed throughout if the best flights are to be had with the finished ship. Every little refinement will add both to performance and appearance.

Purchase these materials for the plane: For the tube, one piece of soft balsa 5/8 by 1¼ by 36″; for caps, one piece ¾ by 1½ by 6½″; for propeller, one piece 1 by 1½ by 15″; for wings, etc., one piece ⅛ by 24″; $\frac{1}{32}$″ music wire 32″ long; for bearing, aluminum $\frac{1}{32}$ by $\frac{3}{16}$ by 1″; light wing tissue paper, 16 by 24″; also ambroid cement, wing dope, fine thread, pins, twine, two celluloid washers to fit the propeller shaft, 4″ of $\frac{1}{32}$″ rubber tubing, and twine. Two 1½″ wheels, of celluloid or balsa, are needed. If of balsa, use three plies of $\frac{1}{16}$″ veneer, cut from a piece 1½ by 9″, and glued together with the grain of the center ply running at 60 degrees with the outer layers.

First of all, cut the wing stock to width, using a ruler or other straight edge to guide the razor blade through the


Removable balsa plug
Tail fin
Stabilizer
Cut wire for front 5 1/8"; for rear, 4 3/4".
Front, 1 3/16"; rear, 1"
1"
1/4"
1/32" music wire
STIRRUP
1/2"
DIHEDRAL
Break spars & glue together at angle
ENDURANCE TUBE
Wing is double surfaced, 4"x24". Rudder and stabilizer are single surfaced.
8"
1/4"
8"
LANDING STRUTS
Tube is 1" inside diameter, & 18" long
Cement landing struts to tube

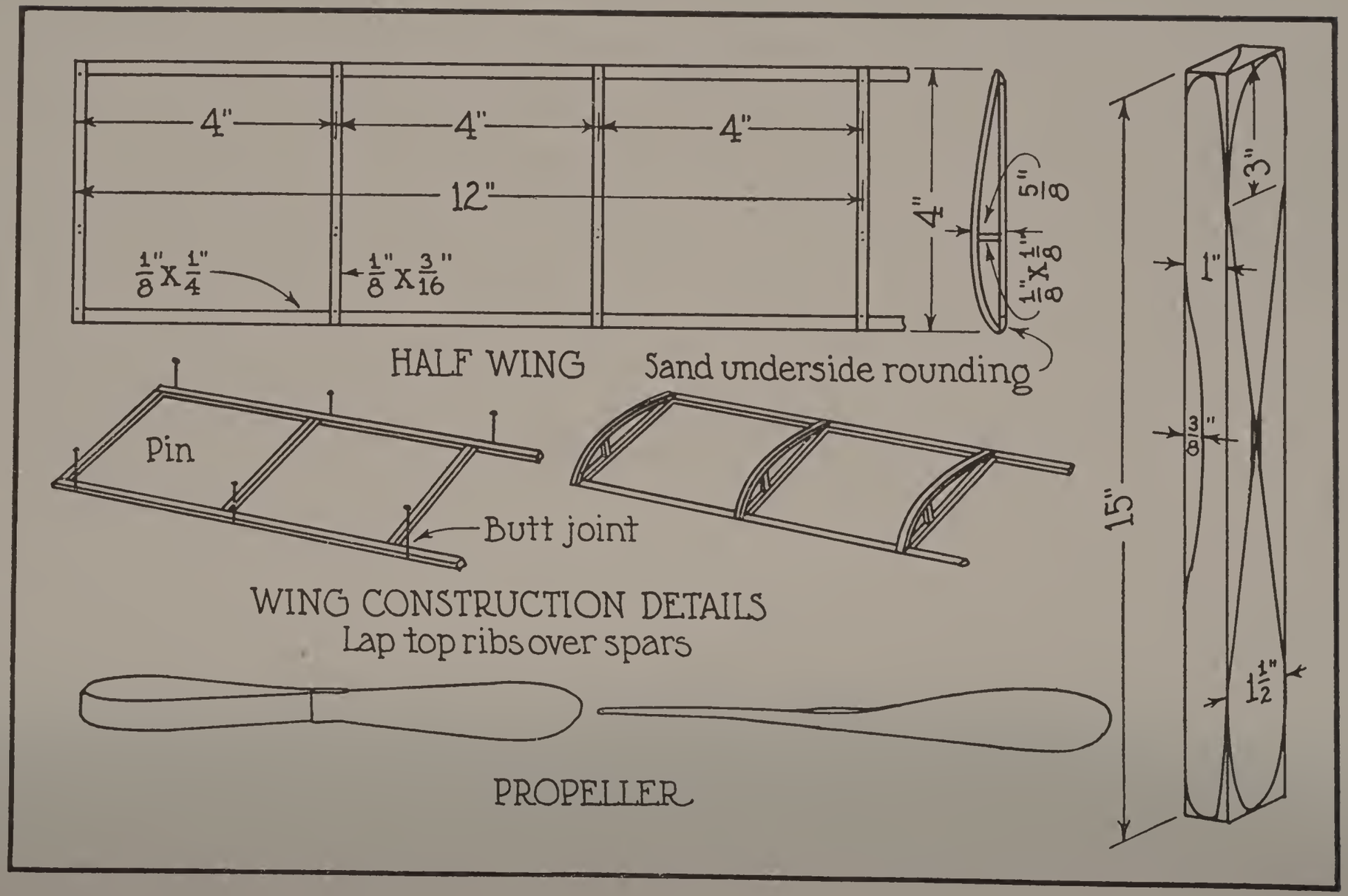
sheet balsa. Make two spars 1/4" wide, and seven ribs 3 1/2" long and 3/16" wide. Seven other ribs 4 1/4" long are also needed.

Sand all these pieces on all sides, rounding the corners a little. To avoid breaking them, rest them on the bench top, and stroke from the center out, so that the sandpaper cannot catch the ends. If the edges of the parts are very irregular, they should be planed straight, using a block plane.

Draw on a board a full-size plan of the wing. Near each rib joining with the spars drive pins along the leading and trailing edges, and lay the spars in place. Then glue the ribs between, making butt joints. If you have trouble keeping the ambroid from cementing the frame to the board, slip scraps of paper under the joints, or cover the plan with waxed paper before driving in the pins.

While the frame dries, camber the upper ribs. One by one lay them on the bench and roll them on one side with a pencil, gradually increasing pressure from the trailing ends to the front ends, so that the deepest part of the curve is about one-third of the way from the front ends. Avoid "bumps" in the finished ribs, since they decrease the lift of the wing and increase drag.

Now lift the frame, clean off blobs of glue and any paper sticking to the joints, and lay it again on the bench with a spar even with the edge. In this position it is easy to

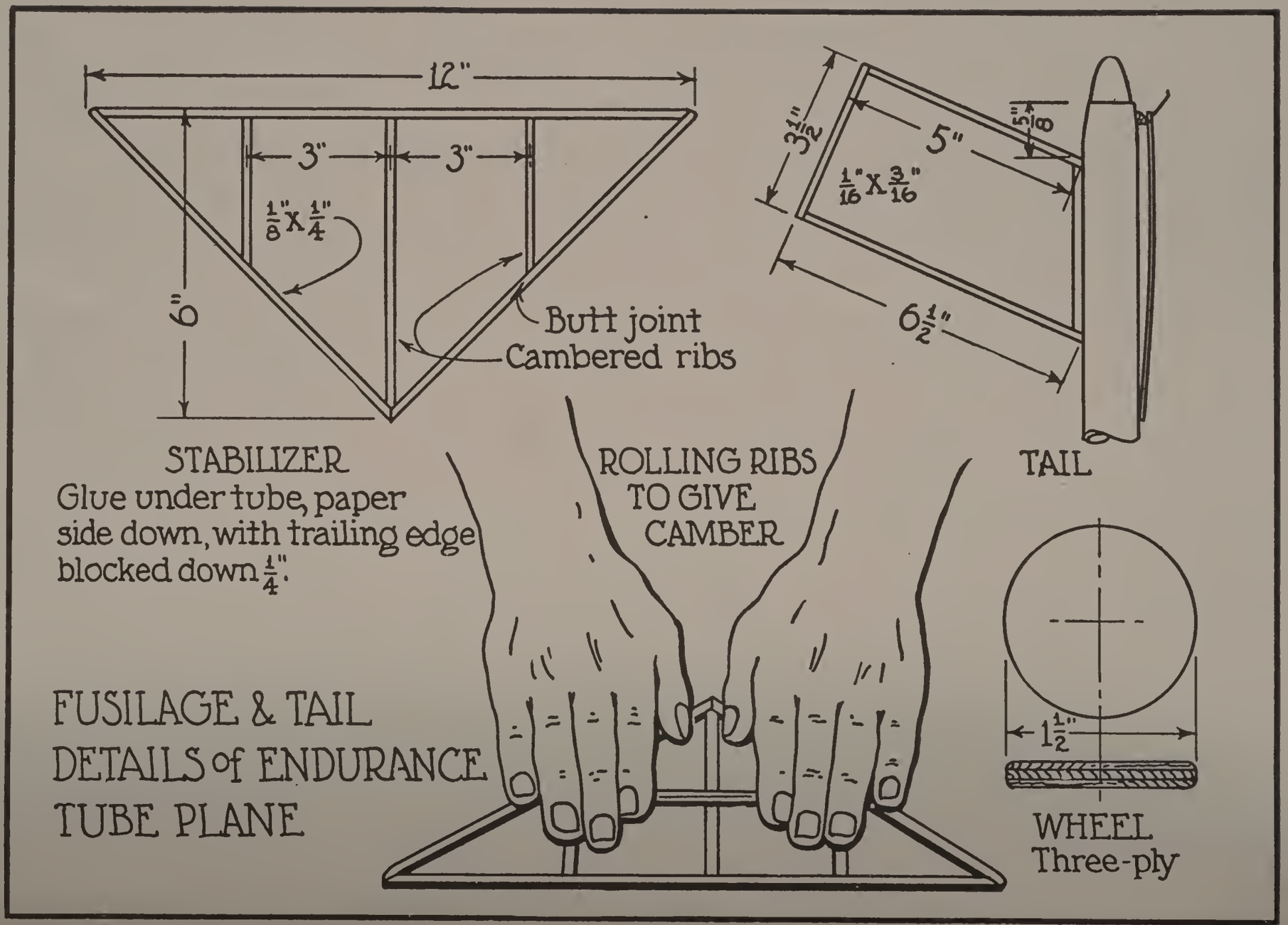

4"
4"
4"
12"
4"
5/8"
1"x1 1/8"
1/8"x1/4"
1/8"x3/16"
HALF WING
Sand underside rounding
Pin
Butt joint
WING CONSTRUCTION DETAILS
Lap top ribs over spars
PROPELLER
15"
3"
1"
3/8"
1 1/2"

sand the outer corner of the upper side. Taper from the under edge to the upper inner edge, thus making the spar triangular in section, as shown in the drawing. Do the same with the other spar.

Once more lay the frame in place over the plan, between the pins, flat side up. With the razor blade slice off the ends of the cambered ribs, so that they will lie flat, and glue them to the spars above the straight ribs, sticking pins through the ends to hold them. Cut a ⅛″ square block ½″ long for each rib, gluing it to reenforce the curved tops.

Let the wing frame dry thoroughly before disturbing it. Then, pressing the thumbs at the center of each spar, and pulling gently upward underneath with the fingers, break the spar. Fill the breaks with ambroid. Block up the ends 2″ above the center, forming the dihedral, and to give extra lift to the left wing, to offset propeller torque, twist up the leading corner ¼″.

Cover half the wing at a time, cutting the paper with about ½″ to spare all around. Dope spread on the spars and ribs with the finger may be used, but it dries so quickly that it is rather difficult to draw the paper smooth. Mucilage is somewhat easier to handle. Apply the under side first, gluing the edge of the paper to the under side of the trailing spar, applying glue to the ribs, and pulling the paper endwise and forward until there are no wrinkles. Bring the tissue up around the leading edge and back over the


12"
3"
3"
6"
1/8" X 1/4"
Butt joint
Cambered ribs
STABILIZER
Glue under tube, paper side down, with trailing edge blocked down 1/4".
3 1/2"
5"
5/8
1/16" X 3/16"
6 1/2"
TAIL
ROLLING RIBS TO GIVE CAMBER
1 1/2"
WHEEL
Three-ply
FUSILAGE & TAIL DETAILS of ENDURANCE TUBE PLANE

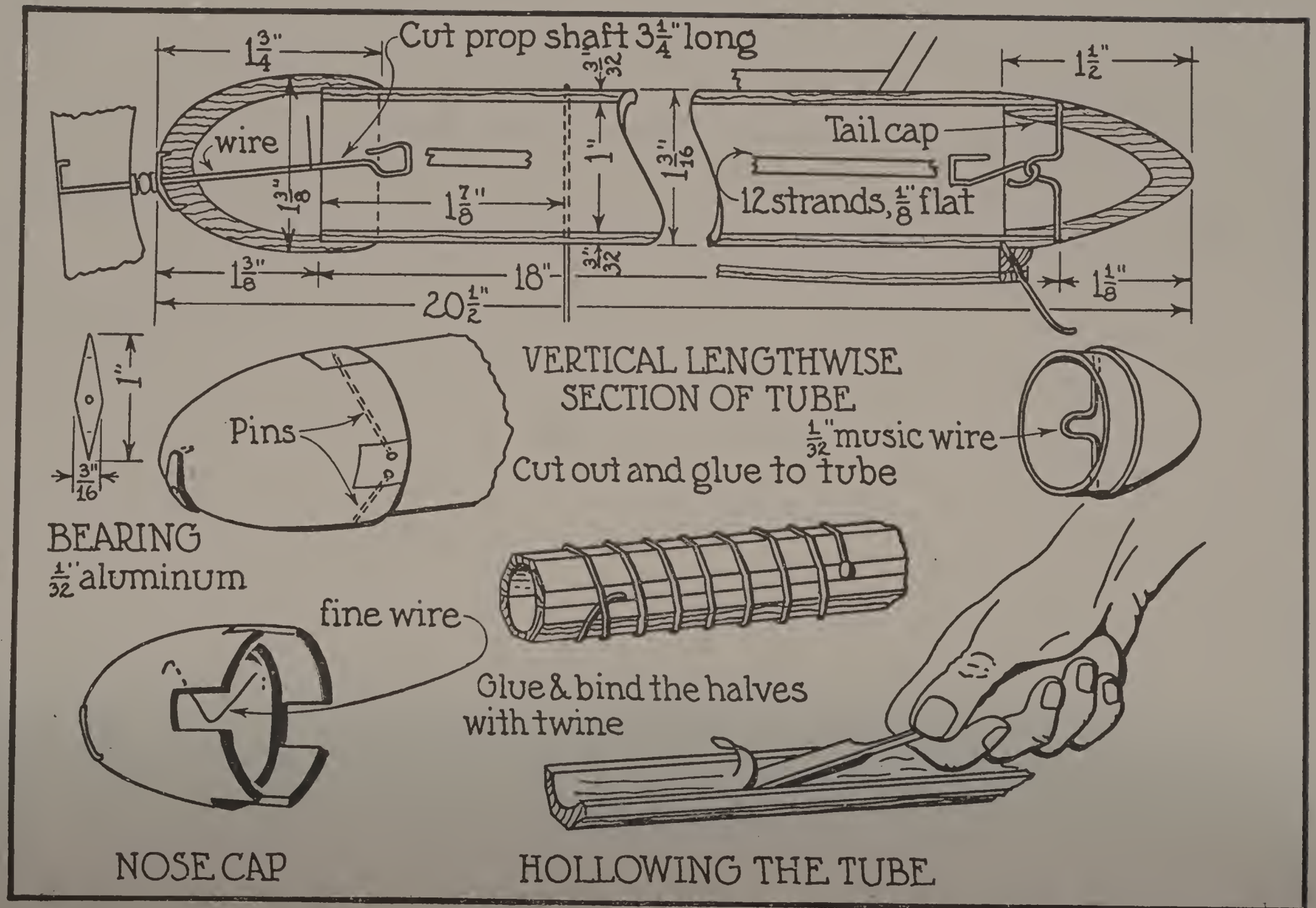
top, finally turning it under the trailing edge, clipping it, and smoothing it down.

The wing stirrups are bent at right angles in the center, as they must span the tube. The ends are bent back at slightly sharper angles, finishing in hooks to clasp the wing spars. The rear stirrup is shorter than the front, so as to give an angle of incidence to the wing of $\frac{3}{16}$". Slip over each a 2" length of rubber tubing, to keep the stirrups from denting the tube, and cement them to the spars.

Give the paper one coat of thin dope.

Now, the propeller. Square the balsa blank, and 3" from each end draw a cross line on each face. Draw diagonals from the ends. Where these lines cross should be the center. Push a pin through this point, and draw lines $\frac{3}{8}$" apart for the sides of the hub. Saw down the diagonals, and carve the blades flat, with a thickness of $\frac{3}{16}$". Camber the outsides, and hollow the insides to a thickness of about $\frac{3}{32}$". Round the ends, and cut away $\frac{3}{8}$" of the hub thickness at the back, tapering nearly to the widest parts of the blades. Smooth the hub, sand the blades, and give two coats of dope, lightly sanding once more with fine sandpaper.

With the wing and propeller completed, the next step is building the fuselage. Cut the tube stock into two pieces, and plane the corners from one face of each, making the section of half and octagon. With a gouge hollow the insides of the pieces so that, when they are put together, they


Cut prop shaft 3¼" long
1¾"
3/32
1½"
wire
Tail cap
1"
1 3/16"
1⅞"
1⅜"
12 strands, ⅛" flat
3/32
1⅜"
18"
1⅛"
20½"
1"
3/16"
Pins
VERTICAL LENGTHWISE SECTION OF TUBE
1/32" music wire
Cut out and glue to tube
BEARING
1/32" aluminum
fine wire
Glue & bind the halves with twine
NOSE CAP
HOLLOWING THE TUBE

have an inside diameter of 1". It will help to make a scraping template, or pattern, from tin, by cutting a circle of tin and nailing it to a short wooden strip with one edge on the diameter. This can be scratched along the hollow until the stick slides on the balsa edges, when the proper depth will have been reached. Sandpaper the hollow.

Apply glue to the edges of the pieces, press them together, and wrap with twine to hold them until dry. Then remove the cord and finish rounding the outside, making the walls $\frac{3}{32}$" thick.

Cut two cap pieces 1¾" long. Whittle their outsides roughly to shape, and then hollow them. Remember that the finished nose cap fits over the tube, having a shoulder to butt against the tube end. So do not carve it too deeply. Pin the parts together to try the fit on the tube, and when this is good, glue the halves together.

The tail cap is a plug, with the shoulder outside, and the forward end entering the tube.

Sand the nose cap smooth, give two coats of dope, and sand again. Cut the aluminum bearing piece diamond-shaped, as in the drawing, drilling it to receive the propeller shaft. Bend the tips at right angles, for pressing into the nose cap, also cambering the bearing outward a little. Notice that the bearing hole is not in the center of the cap, but is ⅛" below. Cement the bearing in place.

With the razor blade cut four rectangular notches in

the flange of the cap. Put the cap in place and glue the pieces removed to the tube, fitting in the places where they were cut out. When the cap is assembled with the tube, pins are thrust through these and the flange parts between, for holding the cap rigidly in place.

For the tail post bend a piece of $\frac{1}{32}''$ piano wire into a "U," afterwards bending the ends at right angles. Slit the tail plug flange, push the wire post into it, and cement. The

S-hook for the motor is hooked into the loop. A pin pushed through the tube and plug holds the plug in place.

Bend the hook on the propeller shaft, thrust the other end through the cap bearing, string on a celluloid washer, a bead, and another washer, and finally the propeller. Bend a hook to press into the hub, and cement.

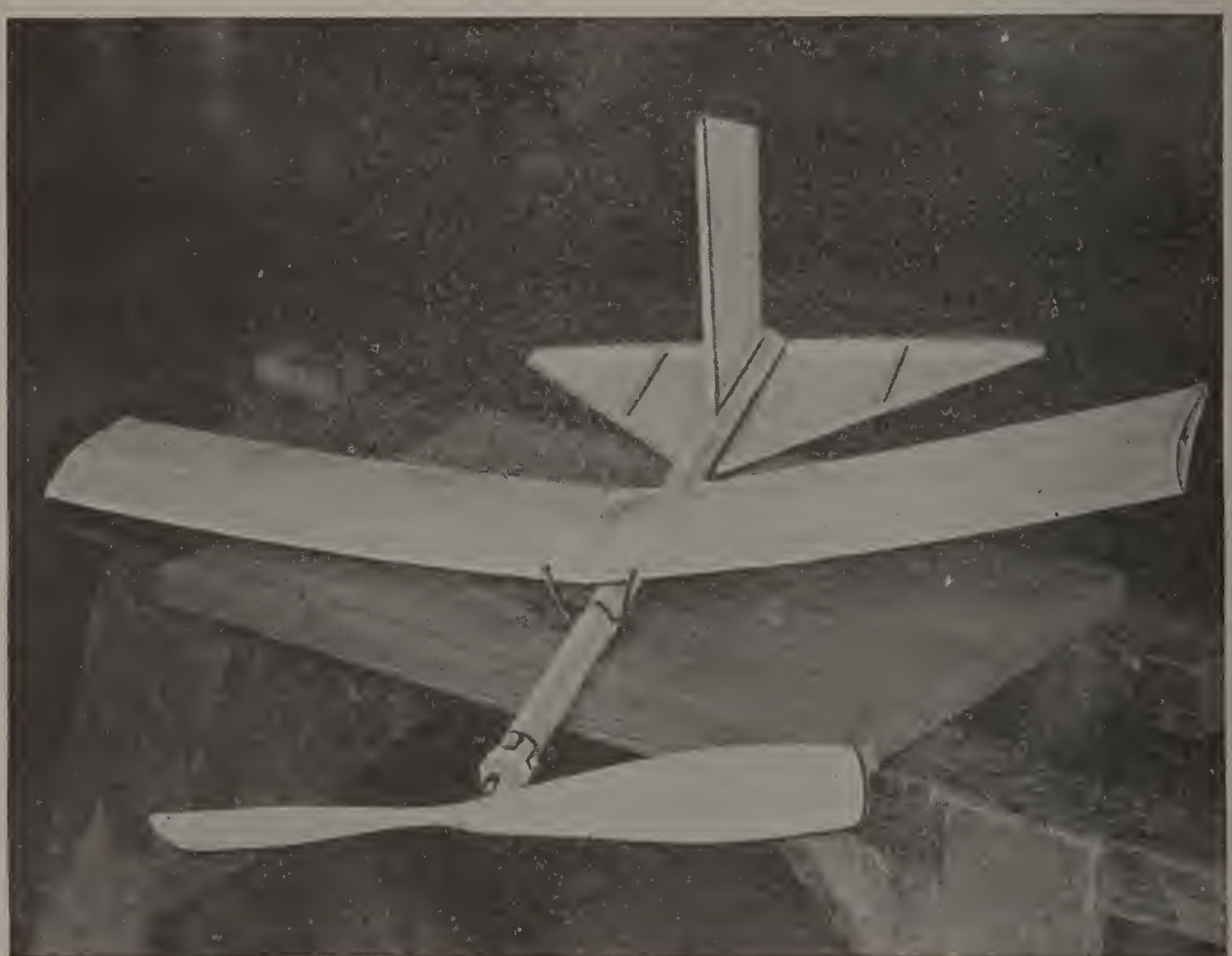
In building the stabilizer, draw a plan for the frame, as was done with the wing. Miter the leading spars together at the front, and butt the trailing spar between the back ends. The three ribs are butted between the front and rear spars. When the frame is dry, roll the ribs lightly to give a slight camber to them. Cover the frame on the under (the cambered) side, and cement the stabilizer under the tube at the rear end, with a ¼" block between the tube and trailing spar. The best glides are obtained with this plane with this positive setting of the stabilizer.

The rudder, or tail, is square on the lower end, with the rib butted over the spar ends. The lower rib butts between the spars. Cover the frame on one side with tissue, and glue the tail to the top of the tube, and the tail assembly is complete. Dope the covering with one coat.

The landing gear consists merely of a music wire bent to fit over the tube, where it is cemented. The lower ends are turned out horizontally, forming wheel spindles.

If ready-made wheels are not used, cut six 1½" squares of $\frac{1}{16}$" balsa, gluing them together in groups of three, with

the grain of the center ply at right angles to that of the outer ones. Drill the centers, and work in cement to harden the hubs so that they will not crush against the spindles. Mount them, building up lumps of ambroid on the spindle ends to prevent them from slipping off.



Attach the wing to the tube with rubber bands stretched from "V" to "V" of the stirrups and under the tube. They must be tight enough to prevent the wing from swiveling around the tube in flight.

Ten or twelve strands of ⅛" rubber are needed for the motor. Rub glycerine on the strands to prevent breakage.

Install the motor and caps, and adjust the wing forward or backward until a good glide is obtained. A nose dive calls for the wing being moved forward, and a stall, the reverse.

Now try a power flight, with the motor about half wound. Very likely the ship will stall. If not, wind fully, and enjoy a splendid flight. To overcome the stall, do not move the wing back, as this will cut down endurance by spoiling the glide to earth. Instead, thread a piece of fine wire through the cap, from side to side, entering 3/8" above the propeller shaft. Loop it under the shaft so as to lift the hook a little, and pin the ends. If the hook-end of the shaft has been raised high enough the plane will gain altitude quickly without stalling. If it has been raised too high, it will go into a nose dive, or fly with short swoops and recoveries. When just the right position of the shaft has been obtained, cement the wire and trim off the extra length.


EDWIN M. LOVE

PART IV

BIPLANES

1

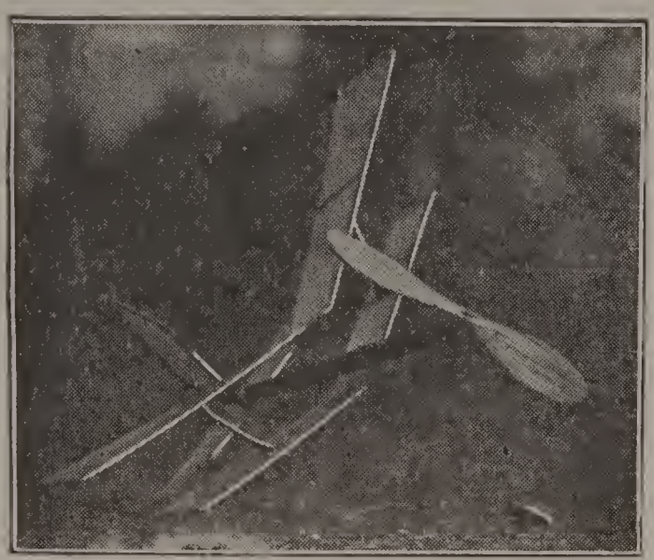
BUILDING THE BIPLANE CUB

Talk about climbing! It is more than surprising to see the little *Biplane Cub* on its first tuned-up flight, for it is off with a rush and scoots up at an astonishingly steep angle, reaching a good elevation before leveling off at cruising speed. The tiny plane, for all its good points, is quickly and easily built, and very durable.

For the motor stick have ready a piece of balsa 1/8 by 1/4 by 8″; for wings, a piece of 1/16″ balsa veneer 1 1/4 by 12″, and rice paper 10 by 12″; for the propeller, a balsa blank 1/2 by 3/4 by 6″; for the bearing, a piece of hard aluminum 1/32 by 1/8 by 3/4″; for shaft, stirrups, landing gear, etc., 20″ of 1/64″ music wire; also two small washers, a glass bead, ambroid cement, wing dope, and thread. The motor takes 14″ each of 1/8″ flat, and 1/16″ square rubber.

First build the wings. These are flat. Split from the 1/16″ veneer two spars 5/32″ wide, and pin them to a board 2 1/8″ apart, measuring from the outer edges. Then cut 1/16 by 5/32″ ribs to fit between the spar ends. Put ambroid on the ends and the spar edges, and put the ribs in place. Also

fit a rib in the center, and two other ribs centered between the end and center ribs.



When the frame is dry, block up the leading left corner 1/8", coat the upper side of the balsa with thin ambroid, and stretch paper smoothly over it. Trim to the wood with a razor blade, and dope.

Carefully cut the wing on the under side of the center rib, spars and all, and bend the wing until the tips rise 2" above the center. Fill the cuts with ambroid, and let dry.

The lower wing is built in the same way, but it is only 1 7/8 by 9". The dihedral is made to fit the upper wing. Like the upper wing, its end corners are clipped off, for neatness and to reduce air resistance.

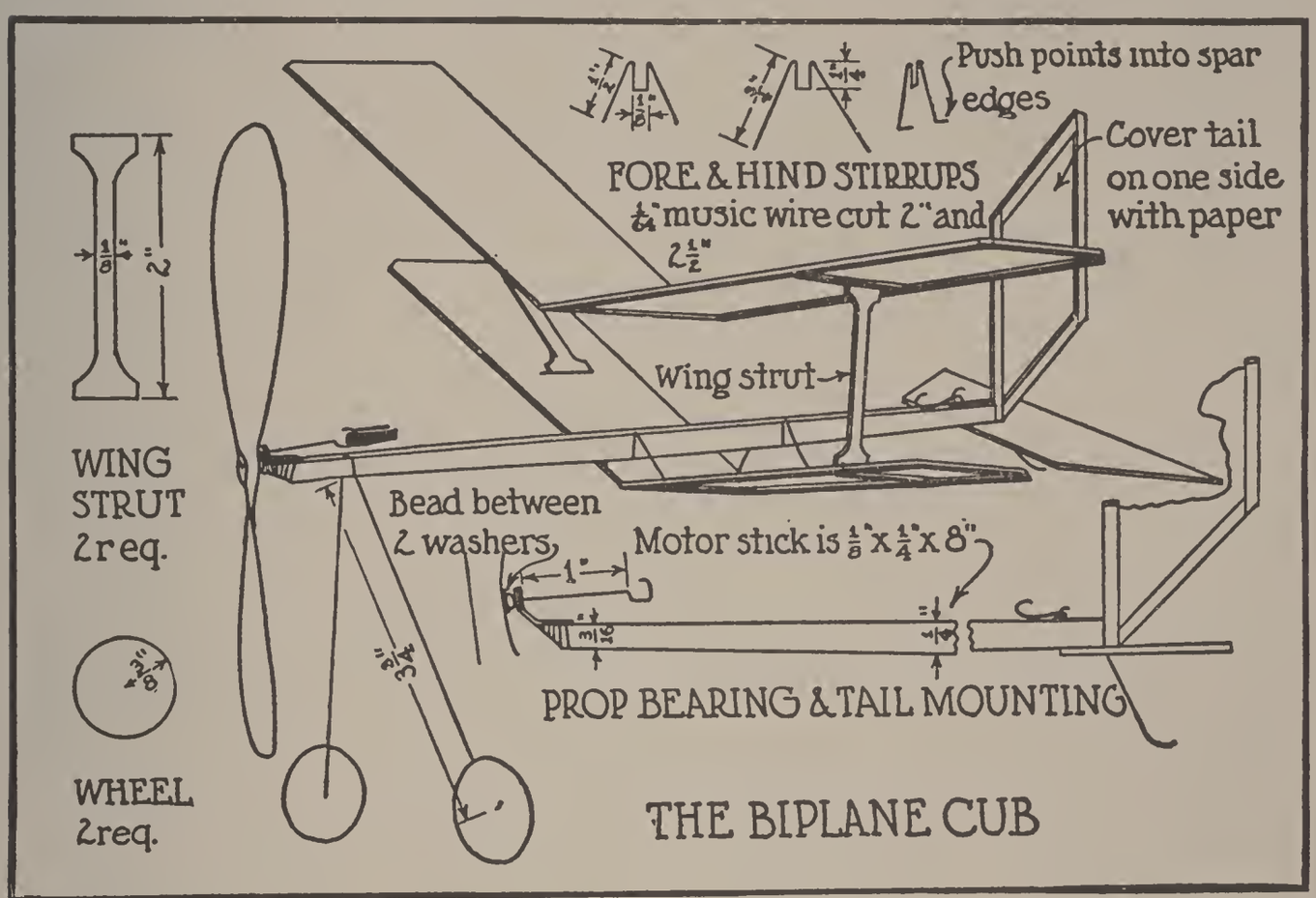
The stabilizer is 1 3/8 by 5 1/4", with the ends mitered. Use balsa 1/16 by 1/8" for the spars and ribs. Only three ribs are needed—the center rib, and the two ends. They are also flat. Cover the upper side with rice paper, and dope.

In making the motor stick, taper the under edge from the center toward the ends, where it is 3/16" wide. Miter the leading end, as shown in the drawing, and sand the corners round.

For the bearing drill a small hole 1/8" from one end of

the aluminum strip. Bend it twice, as shown, so that the end with the hole will be nearly vertical when the bearing is mounted on the motor stick. Cement it to the upper edge at the front end, bind with thread, and cement again.

Ambroid the stabilizer beneath the rear end of the stick,



the leading edge lapping about 3/8". It should be about parallel with the center of the stick.

For the tail skid cut a 2½" piece of music wire. Bend the lower end into the skid.

Now build the tail. On a board draw a rectangle 1¼ by 4". Measure 2¾" along one side, and 2¾" along the other side from an opposite corner. This gives the angle of the ends. Lay down the front and leading edges of $\frac{1}{16}$ by ⅛"

balsa, fitting the ribs between. Cement the joints, and when dry, cover with paper, and dope. Clip the sharp ends. Ambroid the tail to the back end of the stick.

The lower wing is held to the stick with the usual clips or stirrups bent from music wire. They must fit snugly around the stick. The legs of the front stirrup are ½″ long, while those of the rear stirrup are ¾″. The ends of the wire, before clipping, are bent back ⅛″, so that the points can be pushed into the spar edges. Cement them.

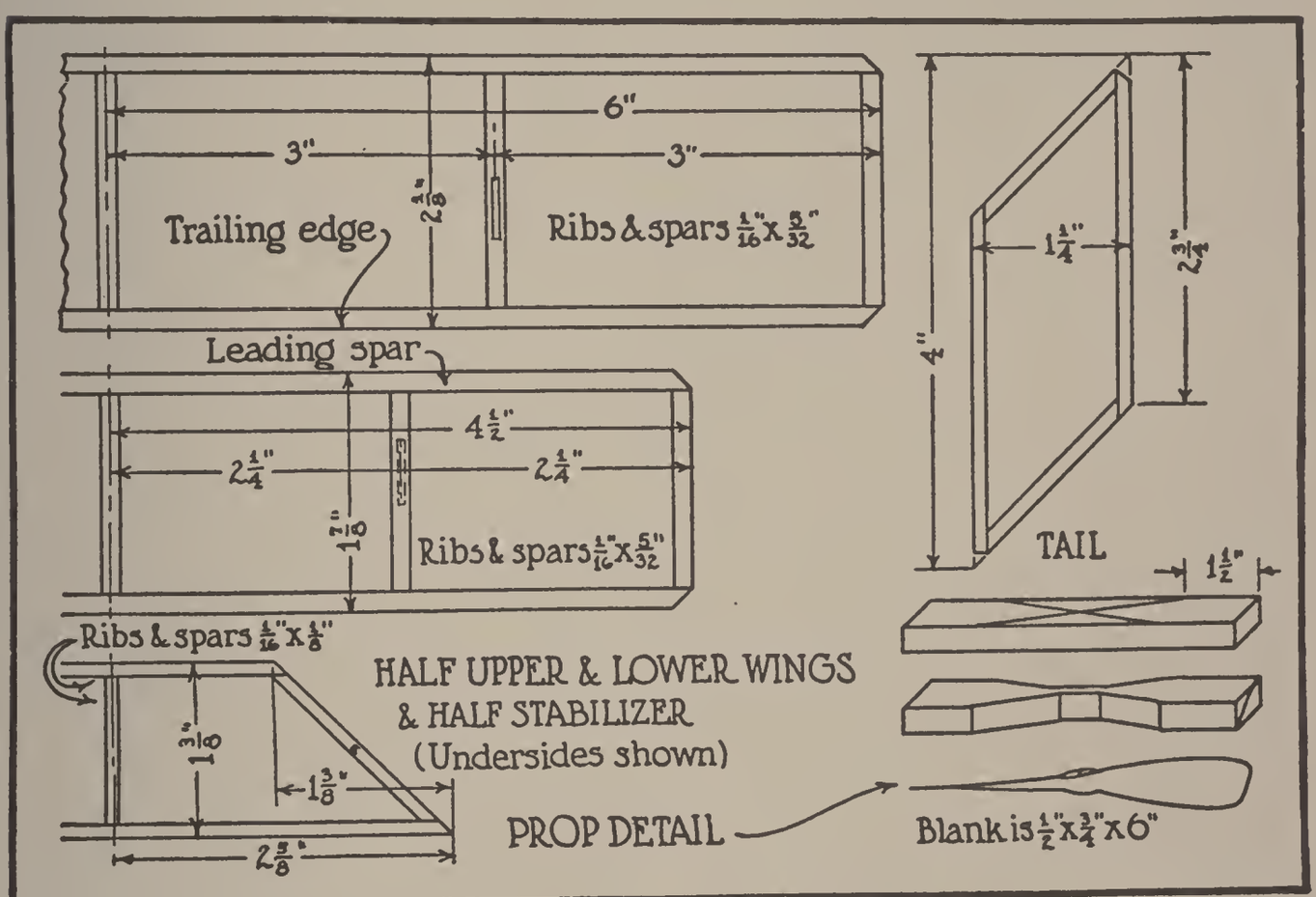
The upper wing is held above the lower with struts. Cut two pieces of balsa ½ by 2″, and shape in the edges to give a width of ⅛″. Cement these to the ribs, as shown, ⅝″ forward of the upper trailing edge, and ½″ behind the lower leading edge, staggering the wings. Be sure to have the upper center over the lower center, with the wings parallel to each other.

The landing gear consists of a piece of music wire 8″ long bent into a clip at the center to fit the motor stick ¾″ behind the front end, where it is cemented. Spread the ends about 3½″, and bend the ends out ⅛″, forming axles for the wheels.

The wheels are ¾″ in diameter, cut from $\frac{1}{16}$″ balsa. Cement them to the landing struts, since it is not necessary that they turn. Remember to have the lower edges closer together than the upper edges, for the weight of the plane when it is standing on the ground, forces the struts

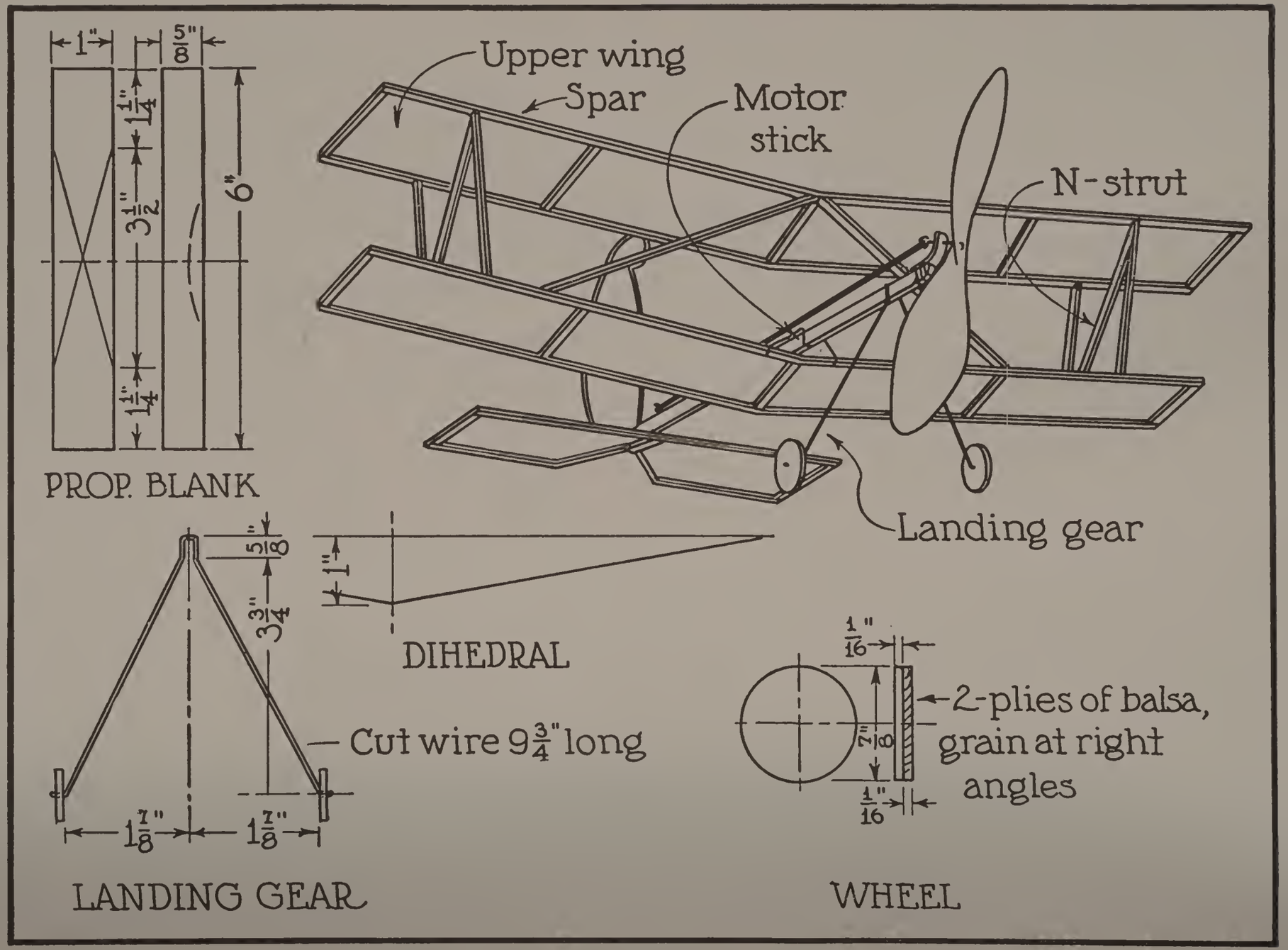
apart and will bring the wheels parallel to each other.

Smooth the propeller blank, measure 1½″ from each end on both faces, and draw diagonals from these points. If accurately done, they will cross at the center. Draw parallel lines ⅛″ apart for the hub, stopping where they meet the diagonals. Cut along the diagonals, and carve the



backs of the blades, making them slightly hollow. Afterwards curve the fronts, round the ends of the blades and other corners, and taper the blades toward the hub from the back, removing ⅛″ of wood. Pierce the shaft hole with a pin, sand the propeller smooth, with the blades about ⅛″ thick at the centers, and it is ready to install.

Cut the propeller shaft 2¼″ long. Bend a rubber hook


1"
5/8"
1 1/4"
3 1/2"
6"
1 1/4"
PROP. BLANK
Upper wing
Spar
Motor stick
N-strut
Landing gear
5/8"
3 3/4"
Cut wire 9 3/4" long
1 7/8"
1 7/8"
LANDING GEAR
1"
DIHEDRAL
1/16"
7/8"
1/16"
2-plies of balsa, grain at right angles
WHEEL

on one end, and push the other end through the propeller hub. Bend a hook on this end, and push the other end through the prop hub. Slip a washer, a bead, and another washer over the shaft, and put it through the bearing.

For the motor use a loop of 1/8" flat rubber and one of 1/16" square. Make the loops about 1/8" longer than the distance between hooks.

Adjust the plane by moving the wings backward or forward until a good gliding position is found, and it is ready for flight.

2

THE N-STRUT BIPLANE

The *N-Strut Biplane,* while not a long flier, is a fast climber and good performer, and is one of the easiest models to build that has been described in this book.

These materials are needed: Balsa, one piece 3/32 by 2½ by 16"; for propeller, one piece 5/8 by 1 by 6"; music wire 1/32" in diameter, 19"; aluminum wire, 1/16" in diameter, 8"; rice paper, 6 by 20"; two celluloid wheels ¾" in diameter (balsa wheels may be used instead); ambroid cement, wing dope, two celluloid washers, one glass bead, pins, and thread. Three strands of 1/8" flat rubber—about 2 ft.—are needed for the motor.

First build the wings. Both are alike, being 2½ by 12½". Cut the spars to width and length and pin them in position

over a plan drawn on a board. Butt the five ribs between the spars and clip off the corners. The wings are better if the edges are sanded rounding. Cover them on one side with rice paper, painting them with thin dope to stretch them tight. Cut half-way through the centers of the spars with a razor blade, and bend them there to form the dihedral angle. Cement, and block in position to dry, at the same time giving a slight upward twist to the front edge of the left wing to overcome propeller torque.

The stabilizer is built in the same way except that a "V" is made in the trailing edge at the center.

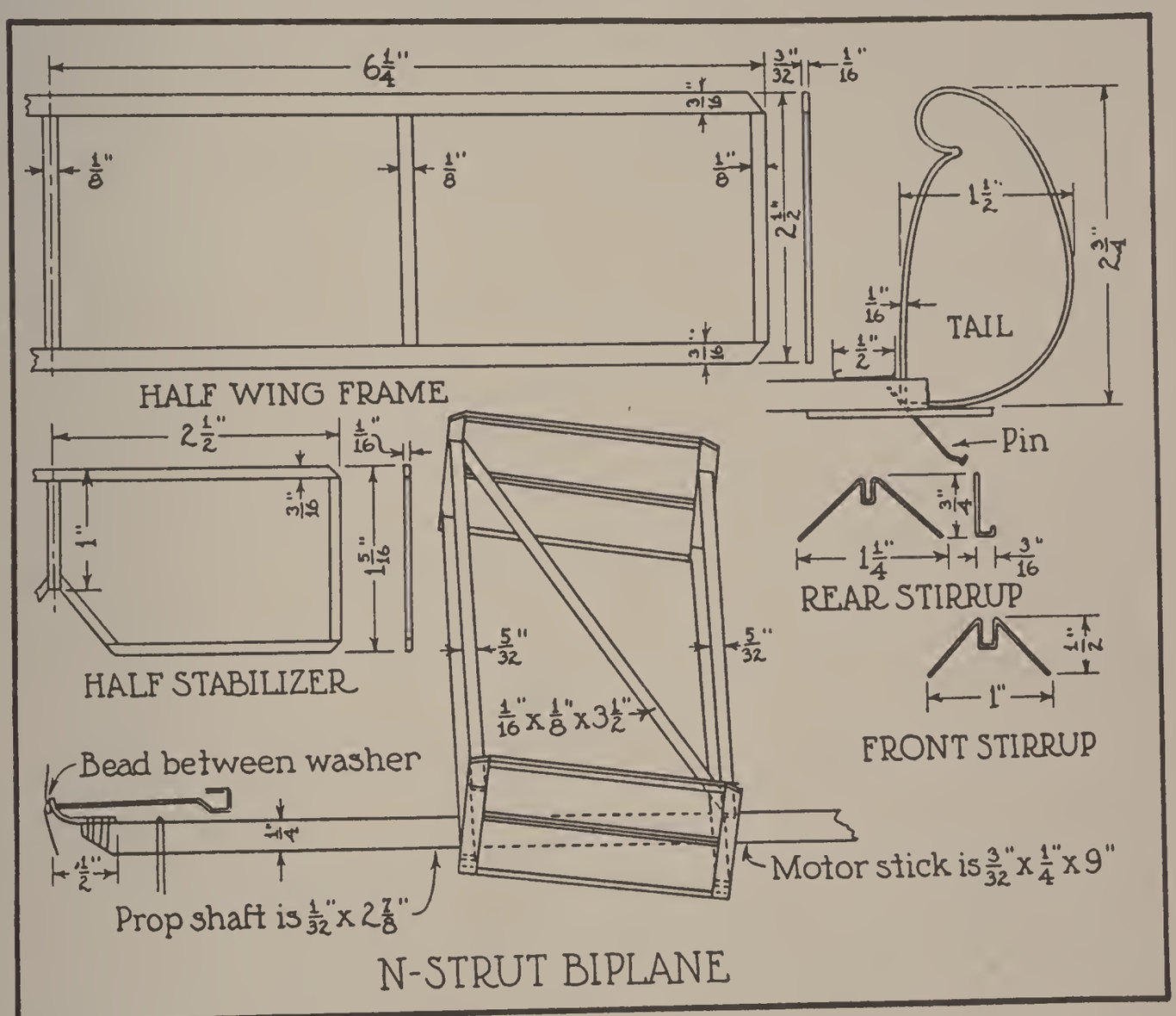
Cut the motor stick to dimensions, sand smooth, and round off the corners. Cement the stabilizer underneath, projecting about ½" behind. A pin thrust through the center rib into the motor stick and bent up at the end serves as a tail skid.

The tail or rudder frame is $\frac{1}{16}$" aluminum wire with the lower end of the leading edge pushed into the upper edge of the motor stick, while the curved trailing edge is forced into the rear end of the motor stick just above the stabilizer. Add a little cement, and cover one side with rice paper.

Drill the aluminum bearing for the propeller shaft and bend it almost at right angles to itself before binding and cementing it to the forward end of the motor stick.

The stirrups are $\frac{1}{32}$" music wire bent into "U's" in the centers to clasp firmly around the motor stick. The ends,

bent at right angles, fit underneath the lower-wing spars. To give an angle of incidence to the wings the rear stirrup should be about ¼″ higher than the front. Cement these to the under wing. Put the upper wing in place by cementing four struts 2½″ long between the two wings. These are



placed about half-way between the two outer ribs of each end, and the wings are staggered by pressing the upper forward ⅛″ ahead of the lower. A diagonal strut between each pair completes the ends. Cement two diagonal struts from the lower wing, meeting at the center of the upper.

The landing gear is bent from music wire, forming a "U" to clasp the motor stick just behind the bearing. For wheels, glue together two $\frac{1}{16}$" thicknesses of balsa with the grain at right angles, or use celluloid wheels. Bend the wire struts at the lower ends to form horizontal spindles, and cement the wheels on these by means of blocks on the tips of the spindles.

The propeller is carved from a straight-grained balsa block $\frac{5}{8}$ by 1 by 6". Sand it smooth. Bend the hook on the propeller shaft and push it into the hub, securing it to the propeller by means of a hook made in front and pressed into the wood. A glass bead between two celluloid washers is used for a thrust bearing.

Make a tail hook of a pin, bending the head at right angles and pressing this into the motor stick just ahead of the tail, where it is cemented.

When the plane is assembled with the wings about halfway between propeller and stabilizer, try it for gliding. If it nosedives, move the wings forward; if it stalls, move them backward. When a good gliding adjustment has been found try it under power. If it stalls, bend the bearing a little more downward. If you have much trouble in getting a good flight try loosening the leading edge of the stabilizer, cementing a $\frac{1}{32}$" or $\frac{1}{16}$" thick balsa block between it and the motor stick. It will then be necessary, of course, to readjust the position of the wings.